FISH PASSAGE CENTER

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ACKNOWLEDGMENTS

We thank all the individuals, agencies, and organizations who contributed to the successful completion of the 1993 program.

Fish marked for the 1993 Smolt Monitoring Program (SMP) were provided by Idaho Department of Fish and Game (IDFG), Washington Department of Fisheries (WDF), U.S. Fish and Wildlife Service (USFWS), and the Oregon Department of Fish and Wildlife (ODFW). We are indebted to the managers and staffs of Wells, Rocky Reach, Winthrop, Leavenworth, Entiat. Priest Rapids, Ringold, Rapid River, McCall, and Dworshak hatcheries, all of whom supplied fish and logistical assistance for the marking program. We extend thanks to the hatchery release coordinators, managers, and staffs of all basin facilities for providing timely information on hatchery releases.

We extend a special thanks to those who marked fish (PIT tagged or freeze branded) for the SMP and to other programs that provided additional marked groups for travel time determinations. Fish marking was carried out by USFWS, IDFG, WDF, ODFW, and Chelan County Public Utility District (PUD).

We appreciate the efforts of the field crews at each of the monitoring sites. Sampling and reporting were carried out by WDF at McNary and Lower Monumental dams, by Washington Department of Wildlife (WDW) at Lower Granite Dam, by ODFW at Little Goose Dam, by National Marine Fisheries Service (NMFS) at John Day and Bonneville dams, and by Chelan County PUD at Rock Island Dam. Juvenile fish traps located near Lewiston, Idaho and one at Whitebird. Idaho, were operated and sampled by IDFG. We wish to extend thanks to researchers at USFWS for their work on the physiological monitoring program.

In addition to the forementioned monitoring supported under the SMP, related activities by others, such as the fish transportation program supported by the U.S. Army Corps of Engineers (COE), provided valuable information at various monitoring sites. The COE also provided facilities and accommodations for smolt monitoring activities at their projects.

This report was prepared by the Fish Passage Center staff: Michele DeHart, Caroline Gray, Tom Berggren. Margaret Filardo. Larry Basham, Dave Marvin, Mike Lim. Lucy Bernard, Ted Vieira. Coral Hughes. and Linda Platten.

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EXECUTIVE SUMMARY

In 1993, flow and passage management for the juvenile salmonid migration was determined by weather and above average precipitation. and the 1993 National Marine Fisheries Service (NMFS) Opinion resulting from Endangered Species Act Section 7 consultations regarding the operation of the federal Columbia River power system. The role of the state agencies and tribes in passage management, as described in the Northwest Power Planning Council Fish and Wildlife Program and in the Northwest Power Planning and Conservation Act, was not recognized in 1993. The agencies and tribes, through the Fish Passage Center. provided System Operational Requests to the hydrosystem operators and regulators, including the NMFS. Issues regarding operations and mitigation measures for listed versus unlisted species were not resolved.

Although January-July runoff volumes were below the thirty-year average (1961-1990), migration flow conditions in the spring period were better than any recent year. The one exception to this was the April flows in the mid-Columbia River reach, which were the lowest observed for the 1975-1993 period. The low mid-Columbia flows were due to the "operations approach" of providing mitigation flows, where April flows were reduced in order to store the Northwest Power Planning Council Program 3.0 MAF flow augmentation volume in upstream reservoirs. Spring period flows resembled a more natural hydrograph and were primarily a result of above-average precipitation and flood control operations, which required reservoirs to pass inflow. in the summer period. July and August flows were determined by the establishment of NMFS flow targets. Temperatures were cooler than average in 1993.

Passage between projects was enhanced by the higher flows provided. Passage at the projects greatly benefitted from high spill levels, due to uncontrolled runoff. Although spill levels were higher than in recent years. biological monitoring indicated only minor incidence of gas bubble trauma. Gas bubble trauma was at its highest level during the highest period of spill, due to uncontrolled runoff and load distribution problems.

The 1993 downstream juvenile migration experienced the best migration conditions in recent years. The high spring flows were due to precipitation and flood control. however the higher summer flows were due to the implementation of summer flow targets. All indicators of downstream passage success, such as passage indices. proportion of marks recaptured. travel time, migration duration. and migration pattern. lead to the conclusion that juvenile salmonids benefitted from the passage conditions that occurred in 1993. Wild and hatchery spring chinook and steelhead responded to the higher flows with faster travel times and a higher proportion of marks reaching sample sites, indicating higher survival. Summer migrating fall chinook of Snake River origin clearly benefitted from the provision of higher summer flows.

Jack returns of upper Columbia and Snake rivers stocks are some of the lowest on record. These fish migrated downstream during 1992. These record low returns are a disturbing contrast to Willamette River spring chinook jacks which outmigrated in 1992 but have returned in numbers above the historic average.

To summarize, the 1993 downstream migration of juvenile salmon experienced much better outmigration conditions than in recent years. Higher flows occurred in the spring, due to above-average spring precipitation and larger runoff volumes. Higher flows in the summer period resulted from implementation of Opinion flow targets. All indicators, passage indices, proportion of marks recaptured, and migration duration and pattern, indicate that fall chinook juveniles in particular benefitted from the passage conditions provided in 1993. Wild and hatchery spring chinook and steelhead responded to the conditions provided with faster travel times and a higher proportion reaching sample sites, when compared to past years, indicating improved survival. High uncontrolled runoff resulted in higher spill levels, benefitting fish passage. High spill levels from uncontrolled runoff resulted in minor incidence of gas bubble trauma. Large scale problems were not observed. Very low returns of chinook jacks and one salt steelhead reflected the dismal ourmigration conditions provided under the 1992 mitigation measures.

FLOWS

- January - **July** runoff volumes were below average at The **Dalles,** Lower Granite, and Grand **Coulee** dams in 1993. The runoff volume in 1993 at Lower Granite was **almost** twice the volume that occurred in 1992.
- Outflow from Grand **Coulee** Dam was lower in 1993 than 1992 for the April through August period. **This** was due to the implementation of the "operations approach" in the first part of the year, **which** concentrated storage activities into **April.**
- Flows at The **Dalles** Dam were significantly higher in 1993, primarily due to flood control operations in the spring. **The NMFS** Opinion flow targets contributed to **higher** flows in the summer period.
- Implementation of **NMFS** flow targets during the 1993 **spring** period **would** have resulted in lower **flows** than those **which** occurred. Higher flows were due to flood control operations. Implementation of the "operations approach" contributed to the lowest flows observed for **April** in the mid-Columbia **River** for the 19751993 period. Summer flows were maintained at higher levels in the **Snake** and Columbia rivers with implementation of summer flow targets.
- The 1993 temperatures were similar to the ten-year average at most sites. Water temperatures at Lower Granite Dam during **July** of 1993 were less than the ten-year average.

SPILL FOR FISH PASSAGE

- In 1993, spill was largely uncontrolled as flows exceeded powerhouse capacity. Uncontrolled flows in 1993 caused overgeneration and load distribution problems that led to additional spill.

- In 1993, spill for fish passage was implemented as defined in the NMFS Opinion. Spill at Ice Harbor Dam was limited to 25 kcfs, and Lower Monumental Dam was considered a collector project by NMFS and the COE. Voluntary spill at collector projects was prohibited by NMFS to facilitate their policy of transporting fish at these projects. Lower Columbia River spill was implemented according to the Regional Spill Agreement. Bonneville Dam was intended to meet a 70/50 bypass standard, but spill was limited during the migration by COE operations.

- Periods of uncontrolled spill in 1993 caused increased levels of dissolved gas. Mild symptoms of dissolved gas trauma were observed in 1-2% of the sample at monitoring sites from 2 to 19 days of the spring migration. The highest incidence was on May 20 at Lower Monumental Dam, when 18.6% of the sample was affected by visible gas trauma symptoms.

JUVENILE SPRING CHINOOK PASSAGE

TRAVEL TIME AND PROPORTION OF MARKS RECAPTURED:

- Yearling chinook released from the Clearwater trap in 1993 had travel time estimates ranging between 22.8 and 6.1 days at flows of 62 to 100 kcfs. The percent detected at Lower Granite Dam ranged from 30 to 50% and had an overall average of 37%.

- Yearling chinook were released for the first time from the Salmon River trap in 1993 and recaptured at Lower Granite Dam. There is a strong relation between flow and travel time (R^2 = 0.61). Travel time at the higher flows from the Salmon trap to Lower Granite was as fast as 4.6 days, with a corresponding migration speed of about 1.2 mph. Wild chinook were consistently smaller than their hatchery counterparts and migrated at a faster rate.

- Yearling chinook were marked and released from the Lewiston trap and recaptured at Lower Granite Dam, as in previous years. In 1993 the percent detected for hatchery fish ranged from 36 to 59%, with an average of 45%. The percent detected for the hatchery fish was adjusted for spill using a 1 to 1 adjustment, considered to be conservative. In 1993, travel time estimates ranged between 13.4 and 3.4 days at flows of 63 to 172 kcfs. Flows were much higher in 1993, and the corresponding travel times were much faster than those observed in 1992.

- Yearling chinook were marked at Little Goose Dam and recaptured at McNary Dam. In 1993 median flows ranged from 78 to 176 kcfs over the time period when releases were made. In 1993, travel time estimates ranged from 9.5 to 4.1 days with an average of 6.2 days, which is a 28% reduction in average travel time from that observed in 1992.

WILD SPRING AND FALL CHINOOK PROPORTION RECAPTURES:

- Recovery proportions of marked wild stocks of spring/summer chinook showed a 10-60% increase in 1993 over recovery proportions in 1992. Some upper Salmon River stocks had a four-fold increase in recapture proportions. Only two groups showed a decline from 1992 recovery levels.

- The recovery proportion of marked Snake River origin fall chinook in 1993 showed a five fold increase over 1992. For the smaller sized fall chinook (60-65mm at time of tagging), which made up 2834% of the Snake River tagged population in the two years, the detection percentage was 17 times higher in 1993. These smaller chinook made up the bulk of the later arriving fall chinook at Lower Granite Dam in August 1993.

- Snake River fag **chinook** migrated over a much longer period in 1993 than in 1992. The early part of the 1992 migration was about **20** days earlier than **in** 1993, while the end of the 1993 migration extended nearly another 50 days longer.

PASSAGE AT LARGE:

- Passage indices at Lower Granite Dam were larger than predicted for **all** species in 1993, when compared with past years.

- High spill levels during most of the spring migration period increased the numbers of **smolts** migrating in-river, but decreased the numbers being counted at dams, thereby affecting the downstream passage indices.

- The ratios of passage indices at Lower Granite Dam to **total** hatchery releases above Lower Granite for 1993 were greater than historical years.

ADULT RETURNS:

- Columbia River **chinook** and **coho** jacks are commonly used to project subsequent adult returns. The 1993 jack returns are fish that outmigrated in 1992. The 1993 chinook jack returns have established new record lows. Steelhead that outmigrated in 1992 are showing very poor one **salt** returns.

I. INTRODUCTION

The Fish Passage Center (FPC) is a technical office of the Columbia Basin Fish and Wildlife Authority (CBFWA). The FPC is a technical staff which operates under the auspices of the state, tribal and federal fishery managers. The FPC was established by the Northwest Power Planning Council (NPPC) through the development of the NPPC Fish and Wildlife Program. Technical advice and guidance is provided to the FPC through the Fish Passage Advisory Committee (FPAC) of the CBFWA, with FPC staff acting as FPAC coordinator. Policy advice and guidance is provided to the FPC through the CBFWA members and their designates.

This Annual Report is submitted to the NPPC to meet Program requirements, and is submitted to the Bonneville Power Administration to meet annual contract requirements. This report summarizes the implementation and analysis activities conducted by the FPC under the auspices of the fishery managers. The intent of this report is to describe the fish passage and migration conditions that occurred in 1993, to summarize flow and spill management for fish migration and to present analysis conducted relative to fish passage.

The purpose of the SMP/FPC program is to collect and analyze fish passage migration, fish passage mitigation management information, and to distribute that information, The SMP/FPC program has endeavored to maintain continuity and consistency in data collection in order to support multi-year analysis.

This Annual Report for 1993 includes historical analyses of flow management, spill for fish passage, migration characteristics. hatchery releases. and adult returns.

II. 1993 OPERATIONS

A. Preseason Planning

Planning for hydrosystem operations during the 1993 juvenile migration season began in February 1992 with the parties to the Pacific Northwest Coordination Agreement (PNCA) submitting their load and resource information for coordinated modelling. This modelling optimizes hydrosystem operations for meeting firm power load foremost and refilling reservoirs as a secondary goal. Based on the results of this exercise and reservoir elevations, a third-year critical operation was adopted on August 1. 1992 for the August 1992 - July 1993 operating year. Eight months before the start of the juvenile migration, minimum power flows and elevations had been scoped out for the year.

Planning for the 1993 juvenile migration season began in February 1993, six months into the operating year. By starting migration season planning after power planning and significant power operations, the flexibility of the hydrosystem was greatly reduced. Cold weather and generation outages led to power drafts of Libby and Hungry Horse reservoirs. These drafts were allowable under the PNCA planning, but the operations had impacts on both spring flows for anadromous fish and reservoir habitat for resident fish.

The operations plan that was proposed for the 1993 migration season was nearly identical to the 1992 Coordinated Plan of Operations (CPO). This operations strategy provided flow augmentation volumes for the Snake River to be accounted for in a "checkbook" fashion. For the Columbia, the flow augmentation volume was provided on top of an unknown and changeable base flow and could not be cleanly detailed. Table I shows the proposed 1993 flow augmentation volumes. The relevancy of the CPO process was called into question when the Fish Operations Executive Committee (FOEC) was advised that the CPO was not a consensus document, nor had it ever been. Discussions at FOEC did not produce any actions. and the CPO remained a COE document. (Draft 1993 CPO in Appendix A.)

While the CPO was being discussed, mainstem water supply conditions appeared bleak. By the end of March, the upper Columbia had only 73% of normal precipitation for the water year, October 1992 - September 1993 (Table 2). The January water supply forecast was below normal at The Dalles Dam, and the CPO required 3 MAF of additional water to be provided for flow augmentation in the Columbia. Given the timetable for flow augmentation planning, it was clear to the fishery agencies and tribes that storing the additional volume would drastically impact March and April flows in the mid-Columbia. And in fact. April flows at Priest Rapids Dam were the lowest observed since 1945.

Table 1. Flow augmentation volumes proposed in the 1993 CPO (thousand acre-feet, KAF)

Source	Spring	Summer and Fall
Dworshak	1,000	470
Brownlee	110	137 summer 100 Fall
USBR above Brownlee	190	100 Fall (137 Brownlee refill)
COLUMBIA	6,450	0

Table 2. Monthly precipitation for the 1992-1993 water year (% of 1961-1990 average)

Month	Columbia River above Grand Coulee	Snake River above Ice Harbor	Columbia River above The Dalles
October 1992	90	100	85
November	82	88	92
December	82	107	92
Januarv	66	105	83
February	29	88	44
March	89	128	106
Aoril	136	162	145
May	95	117	113
June	151	178	166
Julv	223	216	230
August	128	117	131
September	67	17	41
1992-1993 Water Yr.	99	115	103

B. 1993 Water Supply

Despite the low precipitiation percentages for both the Columbia and Snake at the start of 1993 and during the CPO planning, above average precipitation from April through July brought the main basins to average for the water year (Table 2). Due to dry soil conditions, the runoff volumes remained below normal despite the precipitation (Table 3).

Table 3. 1993 Runoff volumes and **forecasts**

	January final forecast	April final forecast	Observed runoff	1961-1990 Avg KAF
Libby (Jan-Jul)	88%	69%	83%	6.40
Hungry Horse (Jan-Jul)	92%	70%	89%	2.27
Grand Coulee (Jan-Jul)	90%	74%	78%	63.23
Dworshak (Jan-Jul)	110%	71%	78%	3.55
Lower Granite (Jan-Jul)	85%	73%	90%	29.74
The Dalles (Jan-Jul)	87%	72%	83%	105.90

C. Spring Flow Conditions

1. Snake River Spring Migration

The middle and upper Snake had well above average precipitation for March and April (Table 2). Brownlee reservoir was near full and passing inflow during April. Dworshak reached its flood control elevation on April 15 and began passing inflow. Under the terms of the CPO, 'all releases from Dworshak over 1.7. kcfs after April 15 were debited from the flow augmentation volume. The fishery agencies and tribes did not request any flow augmentation from Dworshak and objected to this accounting. This argument of accounting for flood control releases has been ongoing since 1983 and the beginning of the Water Budget. By the end of April, 40% of the spring Dworshak flow augmentation volume had been released. The resulting flows at Lower Granite averaged 67 kcfs for April, and 64.2 kcfs for the last two weeks of the month. Figure 1 compares spring flows at Lower Granite in 1993 and 1992. In addition, Lower Granite, Little Goose, Lower Monumental, and Ice Harbor reservoirs were lowered to within one foot of minimum operating pool (MOP) the beginning of April. This operation was at the request of the agencies and tribes and was included as part of the CPO.

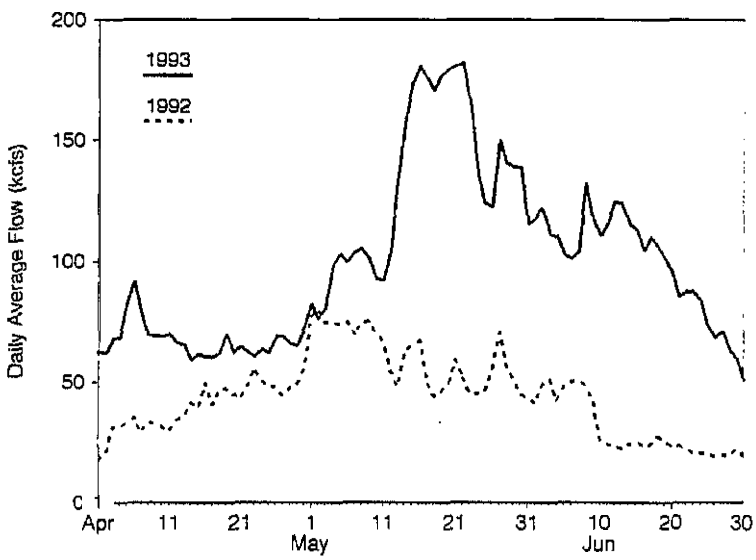


Figure 1. Spring flows at Lower Granite Dam in 1992 and 1993.

For May, releases to maintain flood control space continued from Dworshak and Brownlee. Due to a spill restriction at Oxbow Dam, Idaho Power Company was unable to provide its 110 KAF spring flow augmentation contribution from Brownlee reservoir. Dworshak continued to maintain flood control elevations, and outflow continued to be debited from the flow augmentation. By the end of May, 96% of the Dworshak flow augmentation had been subtracted. May flows averaged 131 kcfs at Lower Granite without any agency and tribal requests. Flows in the lower Snake were as high as 180 kcfs during the month, and hydraulic capacity was exceeded at Little Goose and Lower Monumental dams, and uncontrolled spill occurred.

The NMFS Ooinion was released on May 28, and it changed the operating regime from flow augmentation volumes to flow targets at Lower Granite and McNary (Table 4). The spring flow target for Lower Granite was exceeded throughout the period (April 10 - June 20) due to flood control operations.

Table 4. NMFS 1993 Opinion target flows

Lower Granite		McNary	
April 10 - June 20	85 kcfs	April 7.0 - June 30	200 kcfs
June 21 - July 31	50 kcfs	July 1 - July 31	160 kcfs

During June, the flow situation in the Snake remained the same. Flood control elevations were lifted and Dworshak and Brownlee filled and continued to pass inflow. Flows remained in excess of 100 kcfs at Lower Granite until June 19 and averaged 98.8 kcfs for the month.

For the 1993 spring migration in the Snake, runoff volume and flows were much higher than recent years. Compared to 1992, flows were 160% to 330% higher (see Table 5). The agencies and tribes made no flow augmentation requests nor did the CPO operation strategy affect flows during the spring. However. the flood control vs. flow augmentation accounting issue remains unresolved.

Table 5. Monthly average spring flows 1992 vs. 1993 at Lower Granite Dam (kcfs)

Year	April	May	June
1992	39.7	59.9	29.8
1993	67.0	131.4	98.8

2. Columbia River Spring Migration

During April, flows at Priest Rapids were controlled to meet, but not exceed, the Vernita Bar minimum protection flow of 55 kcfs. averaging 60 kcfs for the month. Flows at Priest Rapids Dam were the lowest observed since 1945. This fulfilled the concerns of the agencies and tribes about implementation of the operations approach to flow augmentation. While mid-Columbia flows were so low. Grand Coulee filled 22 feet and BPA stored 218 KAF into non-treaty storage. Priest Rapids flows for May were projected to be below 134 kcfs, which is the available measurement of the 3.45 MAF Water Budget volume.

On April 28, the COE provided an official flow projection (as per the CPO) of 198 kcfs at The Dalles for the May-June period. Based on juvenile fish passage information, the agencies and tribes requested a reduction in flows during the first week in May so that subsequent weeks could be higher, particularly so late June would not drop below the NMFS target as defined by the federal parties. However, Grand Coulee reached its flood control elevation and began passing inflow early in the month while Dworshak and Brownlee also passed inflow. With these three storage projects releasing inflow to retain flood control space. actual flows at The Dalles exceeded the projection and the fishery request (Table 6). The second weekly flow projection was increased to 220 kcfs, and the agencies and tribes accepted that flow level without modification. However, flows again exceeded the projection, this time by 70 kcfs. Subsequent flow projections declined while actual flows increased and upstream projects continued to pass inflow. The fishery agencies and tribes objected to the flood control releases being debited from the flow augmentation volume and objected to the decreasing flow projections. Following the calculations outlined in the CPO. the entire May-June flow augmentation volume of 6.45 MAF was utilized by May 23, although the only fishery request for the month was to reduce flows.

Table 6. Projected, requested, and actual weekly average flows at The Dalles Dam (kcfs)

Week	Projected	Requested**	Actual	NMFS Target (McNary Dam)
May 1-9*	198	180	215	no opinion
May 10-16	220	220	292	
May 17-23	206	no request	373	
May 24.30	177		313	200
May 31 - June 6	151		261	200
June 7-13	no projection		252	200
June 14-20			208	200
June 21-27			190	200
June 28 - July 4			179	177
July 5-l I			160	160
July 12-18			165	160
July 19-25			163	160
July 26-August 1			156	160
August 2-8			140	no opinion
August 8-15			113	
August 16-22			115	
August 23-29			105	

* The first "week" was 9 days, subsequent weeks were Monday - Sunday.
** Submission of an SOR in response to the projection provided under the COE's CPO process.

Flows for May averaged 150 kcfs at Priest Rapids Dam and 292 kcfs at The Dalles Dam. The flows at Priest Rapids were above earlier projections and were above the 134 kcfs threshold. For May, flows were continually above the NMFS Ooinion McNary target (Table 4). Figures 2 and 3 show 1992 and 1993 spring flows at Priest Rapids and The Dalles respectively.

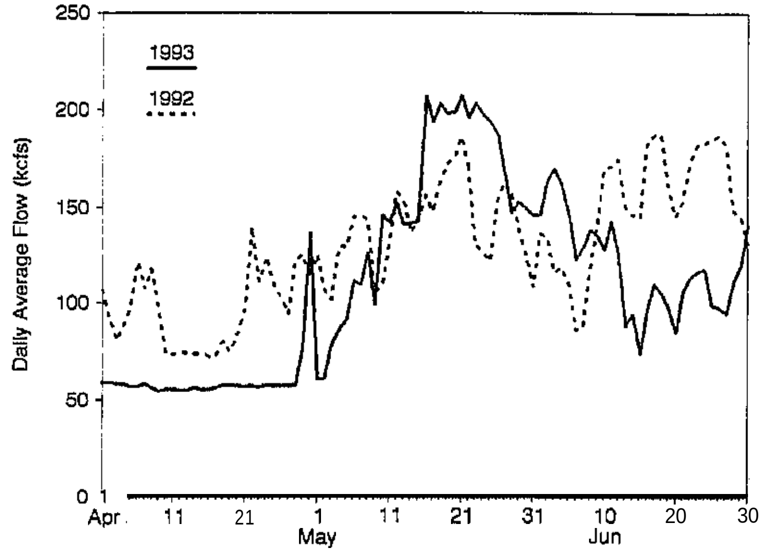


Figure 2. Spring flows at Priest Rapids Dam in 1992 and 1993.

With the advent of the Ooinion in late May, the operational strategy also changed for the Columbia River. The COE stopped providing flow projections the second week of June. Although the strategy changed, actual flood control operations continued to dictate flows for the first half of June. Flows were managed to meet the McNary target during the third week of June. However, COE and BPA proposed decreasing flows for the last week in June to conserve water for the July target. While NMFS tentatively agreed to the change, other agencies and tribes objected on the basis of passage indices and travel times for juveniles already migrating in the lower river. Flows were decreased for one weekend and then were restored. June flows averaged 119 kcfs at Priest Rapids and 223 kcfs at The Dalles.

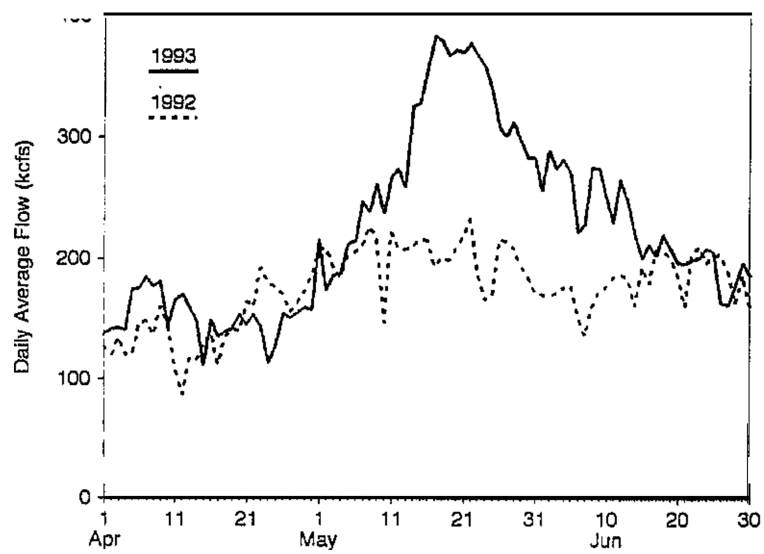


Figure 3. Spring flows at The Dalles Dam in 1992 and 1993.

D. Summer Flow Conditions

1. Snake River Summer Migration

On July 1. both Dworshak and Brownlee were full and passing inflow. These flows were sufficient to maintain the Lower Granite flow target of 50 kcfs. Starting July 4, Dworshak outflow was increased to meet the flow target at Lower Granite. Brownlee began drafting in mid-July also to maintain the flow target. The target was met throughout the month. Dworshak ended the month at a higher than expected elevation due to continued precipitation. Table 7 shows the volumes released to meet the flow target at Lower Granite. These volumes are substantially higher than those specified in the CPO.

Table 7. Volumes provided to maintain Lower Granite target flow (KAF, release is positive, storage is negative)

Period	COE Dworshak	Brownlee	USBR	Net Effect at LGR
July	650	150	150	950
August	390	240		630
September	0	-150 →	150 (backfill)	0
winter	0	-140 →	140 (backfill)	0
Net Contribution	1,040	100	440	1,580

Because of continuing numbers of juvenile subyearling chinook passing at Lower Granite the end of July, the agencies and tribes requested that the flow target of 50 kcfs be extended into August. The COE agreed to draft Dworshak 24 feet and the U.S. Bureau of Reclamation (USBR) agreed to release extra water if it could be passed through Brownlee reservoir. The Dworshak volume was used to maintain the flow target through August 7, and the water from USBR and Brownlee was provided. Figure 4 shows summer flows at Lower Granite for 1992 and 1993.

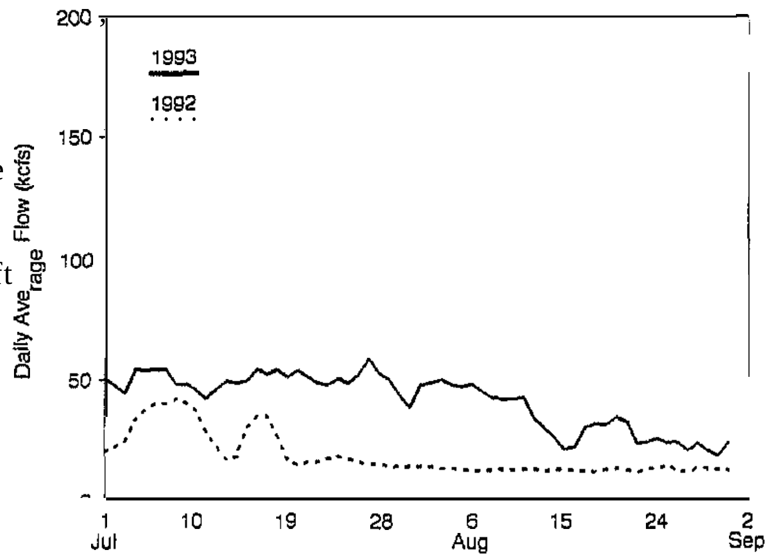


Figure 4. Summer flows at Lower Granite Dam in 1992 and 1993.

The CPO and Opinion allowed the lower Snake River pools to be raised above MOP on August 1. The agencies and tribes objected when this refill operation was planned for mid-August. The COE did raise two pools using the higher flows provided by the Brownlee augmentation releases. The agencies and tribes again objected to refilling the reservoirs with flow augmentation water, and the pools were drafted.

2. Columbia River Summer Migration

The original CPO did not provide any flow augmentation for summer migrants in the Columbia. However, the Opinion specified a flow target at McNary of 160 kcfs for July. This flow was met by upstream releases from non-treaty storage and from Canadian projects in lieu of Libby and Hungry Horse.

The agencies and tribes requested that the McNary flow target also be extended through August to improve migration conditions for juveniles coming out of the Snake. This request was not implemented. BPA did agree to release the planned power flow from Grand Coulee throughout the month rather than reducing it when flows in the Snake were being augmented. While extra measures were provided for July 1993, August flows were not much different than 1992. Figures 5 and 6 show 1992 and 1993 summer flows at Priest Rapids and The Dalles, respectively.

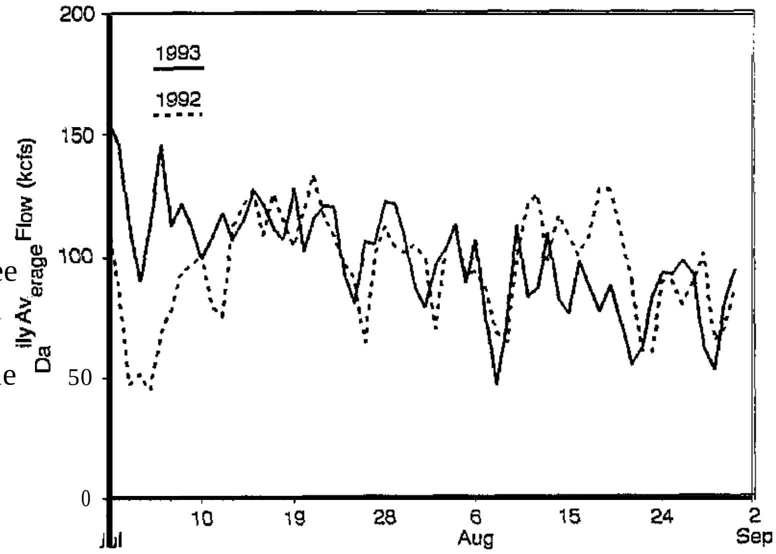


Figure 5. Summer flows at Priest Rapids Dam in 1992 and 1993.

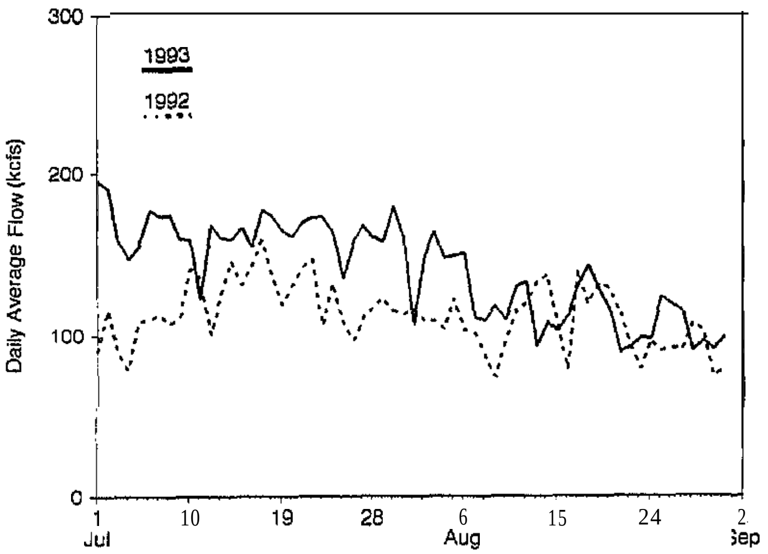


Figure 6. Summer flows at The Dalles Dam in 1992 and 1993.

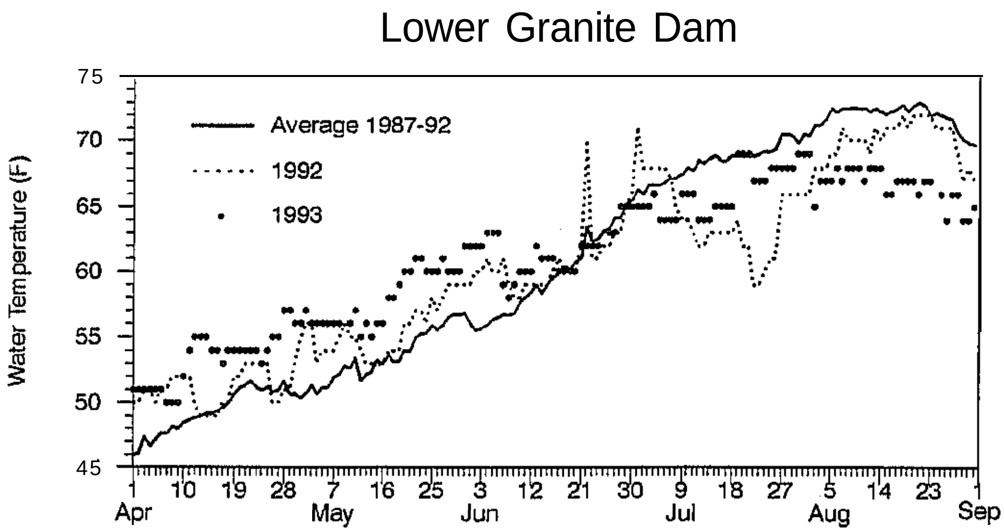
E. Fall Adult Migration Conditions

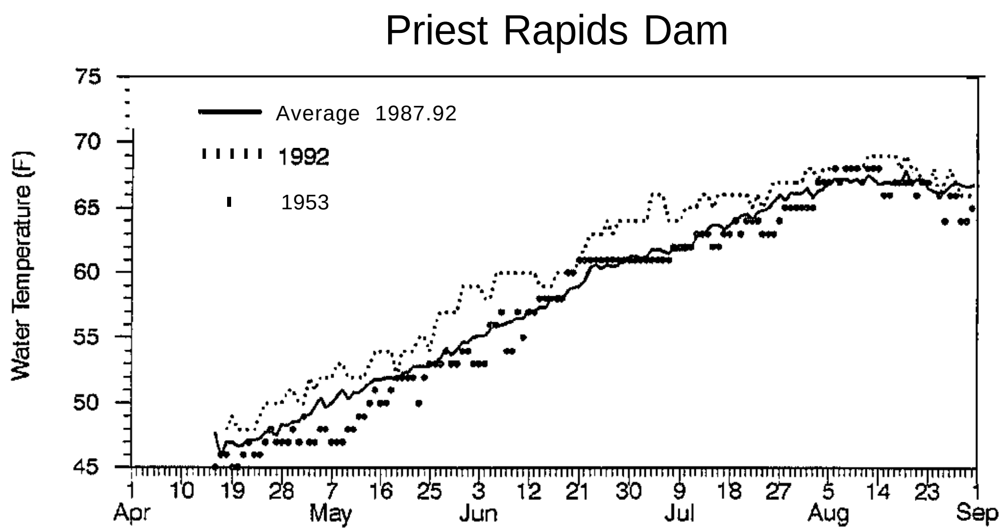
1. Snake River Fall Migration

After flow augmentation for subyearling chinook was exhausted on August 22, flows at Lower Granite Dam decreased to around 20 kcfs for the latter part of August. September flows showed a steady decrease to 14 kcfs mid-month before increasing to 30 kcfs by the end of September as Brownlee drafted prior to fall chinook spawning below Hell's Canyon Dam. The four lower Snake River projects were raised above MOP during the last week of September. In addition, an adult fish radio-tagging study required zero nighttime flows for alternating two week intervals through December. Water temperatures throughout the fall migration were well below the 1987-1992 average following the cold and wet summer (Figure 7). All temperature control water from Dworshak was utilized in August for juvenile migration.

2. Columbia River Fall Migration

August flows at The Dalles Dam decreased from 150 kcfs during the first week with the continuation of the Lower Granite flow target to 90 kcfs by the end of the month. The August average flow was 116





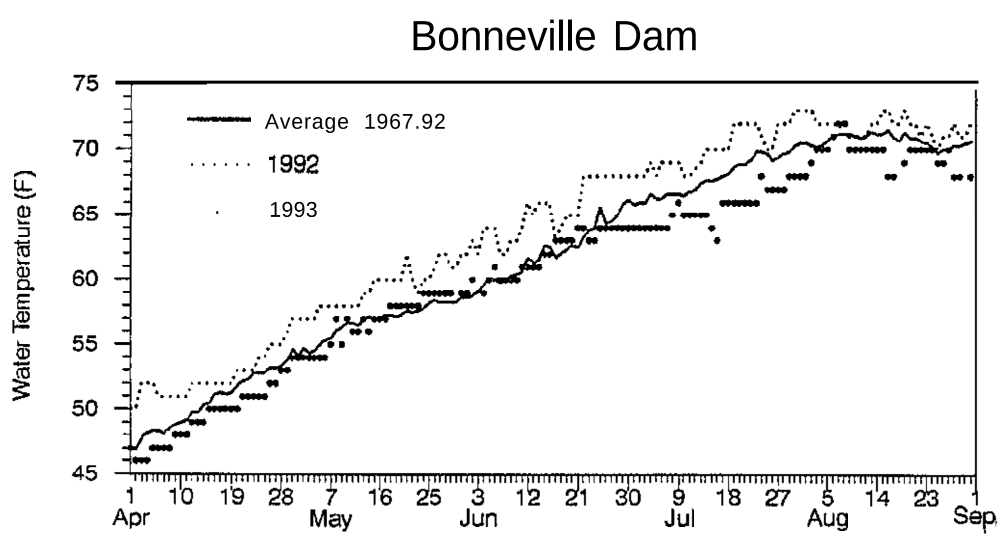


Figure 7. **1993** water temperatures at Lower Granite, Priest Rapids, and Bonneville dams compared to previous years.

kcfs at The Dalles. Flows were shaped weekly for power load. September flows were slightly lower than August averaging 98 kcfs and were again shaped weekly. Water temperatures in the lower Columbia were near average for the two-month period (Figure 7).

F. 1993 Flow Conditions Summary

Spring and especially summer migration conditions were greatly improved in 1993 over those experienced in 1992 with the exception of April flows in the mid-Columbia (Table 8). With above average precipitation from April through July, flood control and natural flows dictated spring operations in both the Snake and Columbia. The NMFS Opinion changed the operating strategy mid-season and provided summer flows. The hydrosystem was able to provide the additional summer volumes outside of the power operating plan and the CPO.

Table 8. 1992 vs. 1993 average monthly flows (kcfs)

Month	Priest Rapids 1992	Priest Rapids 1993	Lower Granite 1992	Lower Granite 1993	The Dalles 1992	The Dalles 1993
April	95.9	60.2	39.7	67.0	143.2	151.1
May	140.8	149.6	59.9	131.4	201.1	292.2
June	151.0	118.9	29.8	98.8	180.5	223.3
July	96.6	113.6	24.6	50.1	119.4	164.3
August	93.4	83.8	13.0	33.3	104.4	116.4

On August 1, 1993. while the end of the flow augmentation was being implemented. the power system adopted and began implementing its operating plan for the 1993-1994 power planning year.

G. Historical Summary

1. Runoff Volumes

The beginning of the Water Budget concept with implementation of the NPPC Fish and Wildlife Program. followed by a succession of below average runoff in the Snake River basin, made the provision of flows for anadromous fish particularly important. From 1983 to 1993. Lower Granite inflow was below the 30-year (1961-1990) average for 8 of the years (Table 9). In fact, Lower Granite inflow has not been average or above since 1986. The effects of this prolonged dry period were apparent in 1993 when precipitation was near normal, but runoff was 90% due to low reservoir elevations and dry soils.

For the Columbia. the past 10 years have not seen many years above average either: however, the amount by which the Columbia has been below has generally been less than the Snake.

2. Water Budget Volumes

The volume of water provided for fish flow augmentation and the implementation restrictions have varied over the past ten years. Table 10 shows the water budget volumes actually provided,

Table 9. January-July runoff volumes

Year	Lower Granite MAF	Lower Granite % avg	The Dalles MAF	The Dalles % avg
1983	38.4	129%	136.2	129%
1984	40.9	137%	111.3	105%
1985	25.2	85%	87.7	83%
1986	36.4	122%	108.3	102%
1987	16.0	54%	76.5	72%
1988	16.4	55%	73.7	70%
1989	23.9	80%	90.6	86%
1990	20.2	68%	99.8	94%
1991	19.1	64%	94.7	89%
1992	14.0	47%	47.6	45%
1993	26.7	90%	88.0	83%
1961-1990 avg	29.7		105.9	

Table 10. Historic Water Budget volumes

Year	Water Budget Volume Provided	
	Snake River	Columbia River
1983	1,200	3,500
1984	0	0
1985	0	0
1986	0	3,140
1987	439	2,520
1988	477	3,450
1989	396	3,180
1990	449	2,660
1991	1,225	0
1992	1,617	6,450
1993	2.880 KAF[1]	7.580 KAF[2]

[1] Spring flows: assuming CPO volumes provided, actual flows result of flood control

[2] Summer flows: volumes released to meet target flows

3. Water Budget Implementation

Of equal or greater importance to the amount of water provided is the ability of the fishery managers to utilize the water in the manner most beneficial to fish. These issues have proven most contentious over the years. There are two basic categories of disputes -- accounting and control.

Questions of accounting for water budget releases as well as ascribing observed flows to fishery requests have been ongoing since 1983. In 1983 and again in 1993. the accounting question was flood control releases being subtracted from the water budget volume without releases being requested by fishery managers. Other accounting disagreements have included the inability to demonstrate the release of 3.45 MAF in the Columbia River.

The other area of conflict in utilizing the water budget is how the water can be shaped for fish. Operations between 1983 and 1993 came full circle; in the early years of the Water Budget which coincided with above average runoff, the goals were target flows of 85 kcfs at Lower Granite Dam (LGR) and 130 kcfs at Priest Rapids Dam (PRD). During the following dry years. it became apparent that the Water Budget volumes were insufficient to maintain the target flows as the base flows decreased. The shaping ability provided to the fishery managers was not sufficient to mitigate the basic problem that the augmentation volumes were not adequate to provide minimum fish flows. Instead of providing the target flows for the entire migration. water was used depending on smoh condition, water temperatures, and juvenile passage information. In 1993, the NMFS Opinion for endangered species from the Snake specified flow targets at Lower Granite and McNary.

Specific highlights of the years are included and shown in Table 11.

4. Water Budget flows compared to 1973-1982 and 1958-1968

Comparing average monthly flows for the ten years before the water budget and the ten years with the water budget in place shows observed spring flows lower after the water budget was created. These results are not encouraging: however, the annual water supply has been below average for most of the water budget era both in the Columbia and Snake. Another important point from the graphs is the shape of the runoff. for the two Columbia projects, the peak of the runoff has clearly been reduced in favor of higher winter flows. At Lower Granite, the control on the runoff is much less, and the shape of the yearly flow has not changed drastically.

To work around the variability in water supply, a more accurate comparison is the percentage of annual flow that occurred in each month compared across the periods. The intent of water budget was IO shift flows to spring and summer. This would show a higher percentage of yearly flow shifted into the water budget months. In addition, such a comparison will show which months were decreased in order to increase migration flows,

Table 11. Specific highlights of years.

1983	- above average runoff for both the Snake and Columbia - releases to maintain flood control space subtracted from water budget volume
1984	above average runoff conditions led to no water budget volume being provided requests for water budget releases given 2nd priority to power marketing decisions Memorial Day weekend flows well below requested levels
1985	- above average runoff forecast led to no water budget volume being provided, however. actual runoff was below average - zero nighttime flows were proposed during July for lower Snake projects - weekend flows were kept to at least 80% of previous week's flow - summer flows in mid-Columbia were record-lows due to upstream reservoir refill
1986	- above average runoff and no water budget requests for the Snake River - Columbia runoff near average and entire water budget utilized to maintain flows raising questions about the size of the water budget
1987	- extremely low runoff volume for the Snake allowed only 11 days of 85 kcfs flows at Lower Granite Dam - fishery managers submitted requests for flows in the lower Columbia in addition to the mid-Columbia and Snake
1988	second extremely low runoff year for both the Columbia and Snake - flows lower than 1987 due to lower base power flows 8 days of augmentation provided at Lower Granite Dam - Snake augmentation caused lower flows in the mid-Columbia as electricity was generated from Dworshak and the lower Snake proiects
1989	- runoff volume improved, but still below average - summer refill operations caused flows lower than 1987 and 1988 at The Dalles Dam
1990	- 9 days of augmentation provided at Lower Granite Dam - all fisherv requests for the Columbia worded in terms of flows at The Dalles Dam
1991	- lower Snake River projects drafted to near minimum operating pool (MOP) to increase water panicle travel time through the reservoirs - shifting of flood control requirements from Dworshak to Grand Coulee provided an additional 400 KAF of flow augmentation for the Snake River - summer augmentation volume of 131 KAF was provided for the Snake River - 100 KAF was released from Dworshak Dam for water temperature control the latter half of August
1992	- another below average runoff year 400 KAF summer water budget provided for the Snake River - Columbia River water budget officially accounted at The Dalles Dam - 3 MAF of additional water budget provided for the Columbia River - 250 KAF of Columbia spring augmentation carried over for summer augmentation Snake augmentation caused lower flows in the mid-Columbia as electricity was generated from Dworshak and the lower Snake projects
1993	- spring flows at Lower Granite and The Dalles dams controlled solely by releases to maintain flood control space - summer augmentation provided to maintain NMFS flow targets at McNary and Lower Granite dams

At Priest Rapids Dam. the effect of the 3.45 MAF water budget is not visible (Table 12 and Figure 8). While May flows increased slightly, June flows decreased by a larger amount, and July and August flows were severely impacted. In fact, the largest increase in percentage of flow was seen in December. These flows are not explained easily for any reason except power production since Grand Coulee above Priest Rapids has no flood control requirements in December. The shift in flows from the pre-water budget era to the water budget era has not been a shift beneficial to migrating juvenile salmonids. but appears to have been beneficial to power production.

At Lower Granite Dam, the shift pattern between 1973-1982 and 1983-1992 is different but not of a large magnitude (Table 13 and Figure 9). Both April and May show an increase in flow, but June and July flows show an even larger decrease. The single largest increase was seen in March flows. The higher overwinter storage in anticipation of spring water budget volumes could result in higher March flood control releases. The December and January decreases could also reflect this operation, However, the cause of the March increase may not be entirely attributable to this operation. Overall, the change in flow pattern at Lower Granite since the advent of the water budget has not provided the objective of higher spring and summer flows for juvenile outmigration; with April flows only slightly higher, and summer flows strongly impacted.

At The Dalles Dam, the change in flow pattern is a blend of the two upriver patterns (Table 14 and Figure 10). March and April flows were higher even though the official spring migration season for the lower river is May and June in hydrosystem planning. As was the case at LGR and PRD. June and July were the months that suffered the decreased flows. The changes in flows at The Dalles are even less noticeable than at the upriver projects,

Table 12. Average percentage of total annual flow at Priest Rapids Dam, 1973-1982 compared to 1983-1992.

Month	1973-1982	1983-1992	Difference
January	8.8	9.2	0.4
February	7.8	8.2	0.4
March	8.6	8.9	0.3
April	8.1	8.7	0.6
May	10.6	11.2	0.6
June	11.0	10.3	-0.7
July	10.0	8.2	-1.8
August	8.4	7.2	-1.2
September	6.3	5.7	-0.6
October	6.3	6.3	0.0
November	6.7	7.2	0.5
December	7.5	8.9	1.4

Table 13. Average percentage of total annual flow at Lower Granite Dam, 1973-1982 compared to 1983-1992.

Month	1973-1982	1983-1992	Difference
January	1.2	6.8	-0.4
February	6.6	6.9	0.3
March	8.8	10.3	1.5
April	10.9	11.3	0.4
May	16.7	17.7	1.0
June	17.0	14.7	-2.3
July	7.5	6.5	-1 .o
August	3.8	4.2	0.4
September	4.3	5.4	1.1
October	4.4	4.7	0.3
November	5.4	5.5	0.1
December	7.4	6.0	-1.4

Table 14. Average percentage of total annual flow at The Dalles Dam, 1973-1982 compared to 1983-1992.

Month	1973-1982	1983-1992	Difference
January	8.6	8.6	0.0
February	7.7	8.0	0.3
March	8.9	9.8	0.9
April	9.2	10.0	0.8
May	12.4	12.7	0.3
June	12.4	11.3	-1.1
July	8.9	7.4	-1.5
August	6.7	6.1	-0.6
September	5.6	5.4	-0.2
October	5.8	5.9	0.1
November	6.3	6.7	0.4
December	7.6	8.0	0.4

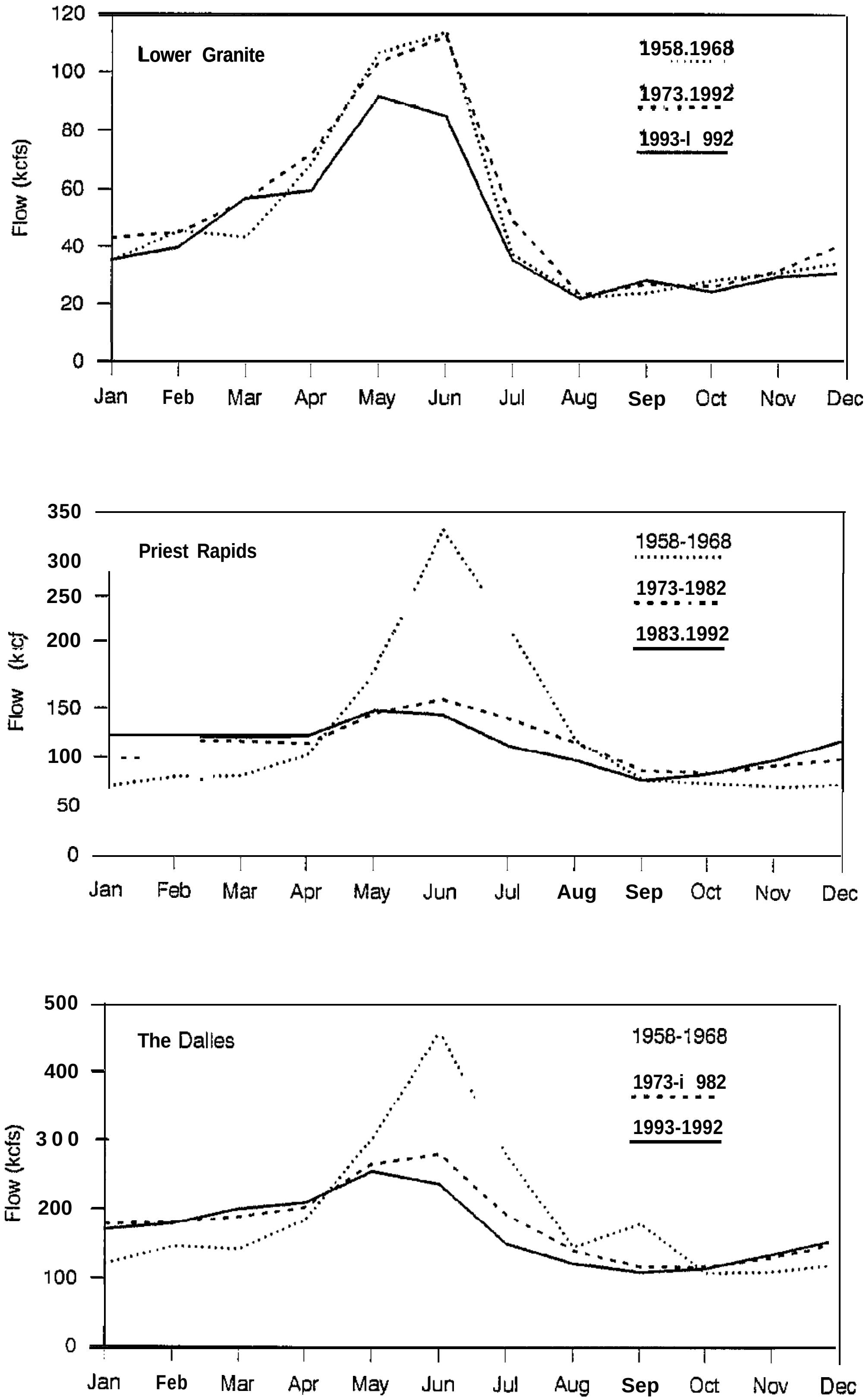


Figure 8. Monthly average flows at Lower Granite, Priest Rapids and The Dalles dams, 1958-68, 1973-82, and 1983-92.

The most striking feature of the preceding tables is how little the flows have been changed between the 1970's and 1980's. A much larger change has occurred in the pattern of flows between the 1958-1968 period and the present. Between 1958-1968, Snake River chinook stocks were self-sustaining. Tables 15 through 17 compare percent of flow at the three dams between this period of sustained populations and the past ten years.

Table 15. **Average** percentage of total annual flow at The Dalles Dam, 1958-1968 compared to 1983-1992.

Month	1958-1968	1983-1992	Difference
January	5.5	8.6	3.1
February	6.1	8.0	1.9
March	6.5	9.8	3.3
April	8.2	10.0	1.8
May	13.8	12.7	-1.1
June	20.2	11.3	-8.9
July	12.7	7.4	-5.3
August	6.1	6.1	-0.6
September	4.8	5.4	0.6
October	5.0	5.9	0.9
November	4.9	6.7	1.8
December	5.6	8.0	2.4

Table 16. **Average** percentage of total annual flow at Lower Granite Dam, 1958-1968 compared to 1983-1992

Month	1958-1968	1983-1992	Difference
January	6.1	6.8	0.7
February	7.1	6.9	-0.2
March	7.6	10.3	2.7
	11.4	11.3	-0.1
May	18.5	17.7	-0.8
June	19.0	14.7	-4.3
July	6.3	6.5	0.2
August	3.8	4.2	0.4
September	4.0	5.4	14
October	4.9	4.7	-0.2
November	5.2	5.5	0.3
December	6.1	6.0	-0.1

Table 17. Average percentage of total annual flow at Priest Rapids Dam, 1958-1968 compared to 1983-1992

Month	1958-1968	1983-1992	Difference
January	4.9	9.2	4.3
February	4.9	8.2	3.3
March	5.6	8.9	3.3
	6.8	8.7	1.9
	12.7	11.2	-1.5
June	21.7	10.3	-11.4
July	15.7	8.2	-7.5
August	8.0	7.2	-0.8
September	5.1	5.7	0.6
October	5.0	6.3	1.3
November	4.7	7.2	2.5
December	5.0	8.9	3.9

The change in seasonal shape of the hydrosystem has been towards higher flows during fall and winter to meet electricity demand. The efforts of the past ten years to shift some of the operation back to the natural spring and summer runoff have had only a minor effect on flows.

III. 1993 SPILL IMPLEMENTATION

A. Spill Planning

In April of 1993, the Oregon Department of Fish and Wildlife, Idaho Department of Fish and Game, United States Fish and Wildlife Service, and the Indian tribes (Fishery Managers) transmitted their recommendation for the 1993 Operations Alternative. This document recommended that spill in 1993 achieve the 80/70 Fish Passage Efficiency (FPE) established by the fishery managers in 1986 (Juvenile Fish Bypass Performance Standards for Mainstem Dams on the Columbia and lower Snake Rivers, December 4, 1986). On April 9, a System Operational Request (SOR) was submitted specifying spill levels necessary to achieve the recommended FPE. Prior to the issuance of the NMFS Biological Opinion. the COE spilled in accordance with their Fish Passage Plan (FPP), which only called for spill at the non-collector projects at levels required to meet a 70/50 FPE. These criteria applied to Ice Harbor and Bonneville dams. Spill at The Dalles and John Day Dam were planned to comply with the 1989 Fish Spill Memorandum of Agreement (MOA). The mid-Columbia projects provided spill according to their individual FERC agreements.

In 1993, the Fish Passage Center instituted a monitoring program for gas bubble trauma symptoms in concert with the fish sampled for smolt monitoring purposes. Smolt monitoring crews routinely sampled fish and ranked them according to pre-determined criteria. The information was transmitted to the FPC regularly for assessment along with other smolt monitoring data.

Planned spill was managed according to the COE's FPP and results of consultations with NMFS until the Biological Opinion was issued on May 26, 1993. The Opinion prohibited planned spill at the collector projects, limited spill at Ice Harbor. called for the removal of screens at Ice Harbor and Bonneville dams during the summer migration and implemented spill according to the Spill MOA at John Day and The Dalles dams. Spill as mitigation for turbine mortality was provided as described in the Biological Opinion and the COE's FPP, far below the spill recommendations made by the regional Fishery Managers.

B. Sail1 Implementation

As part of their 1993 Operations alternative, the Fishery Managers recommended that a no-transport option be implemented for spring migrants. Along with that option was included a spill program that was designed to achieve the functional bypass standards that the agencies and tribes developed more than five years prior to the 1993 migration. The intention was for improved in-river migration conditions at the project. which would enhance the overall survival of fish and the ultimate recovery of Snake River stocks.

1. Lower Granite Dam

Spring spill was requested as 78% of instantaneous flow from 1800-0600 hours from April 15 through May 31. No planned spill occurred at this project during 1993 because of its collector project status.

Spill in excess of hydraulic capacity and overgeneration spill (spill that occurs because of an inability to market the generation available) occurred between May 13 and June 15 in varying amounts (Figure 9). Summer spill was requested as 77% of instantaneous flow during nighttime hours (1800-0600) from June 1 through August 31. No spill occurred at this project during the summer of 1993.

2. Little Goose Dam

Spring spill was requested as 48% of instantaneous flow from 1X00-0600 hours from April 15 through May 31. No planned spill occurred at this project during 1993 because of its status as a collector project. Spill in excess of hydraulic capacity and overgeneration spill occurred between May 1 and June 19 in varying amounts (Figure 10). The hydraulic capacity at this project was severely limited because of FGE research being conducted. Two units were equipped with extended length screens, and were not available for generation because of potentially detrimental impacts on juveniles. However, these units were used to generate during the highest flow period because of the dissolved gas symptoms observed in fish sampled downstream at Lower Monumental Dam. Load distribution problems associated with weekends also caused high levels of spill, even when units were available for operation. Spill during this period far exceeded what the fishery managers recommended. Summer spill was requested as 77% of instantaneous flow during nighttime hours (1800-0600) from June 1 through August 31. No spill occurred at this project during the summer of 1993.

3. Lower Monumental Dam

Spring spill was requested as 61% of instantaneous flow from 1800-0600 hours from April 15 through May 31. No planned spill occurred at this project during 1993. NMFS and the COE regard Lower Monumental Dam as a collector project and would not spill voluntarily regardless of the FGE associated with the project. Spill in excess of hydraulic capacity and overgeneration spill occurred between May 4 and June 19 in varying amounts (Figure 11). On the weekend of March 27-28 the COE made a decision to release project personnel from the Snake projects since the permit to transport fish had not yet been issued. Local flooding plugged the bypass system causing the system to overflow and undermined the bypass system supports. In addition, the emergency bypass system failed and, therefore, the Fishery Managers requested that spill be implemented immediately to achieve the 80% FPE assuming no operational bypass. The COE did not implement the request on the basis of fish numbers salvaged from the gatewells. NMFS agreed with the COE that the listed species had not yet started migrating and believed the implemented program (gatewell dip, report results. and watch trap catch data) was adequate. The bypass was repaired on April 6 and in service by 1600 hours,

Summer spill was requested as 81% of instantaneous flow during nighttime hours (1800-0600) from June 1 through August 3 1. No spill occurred at this project during the summer of 1993.

4. Ice Harbor Dam

In pre-season planning it was decided to operate the bypass system with screens intact, but no credit

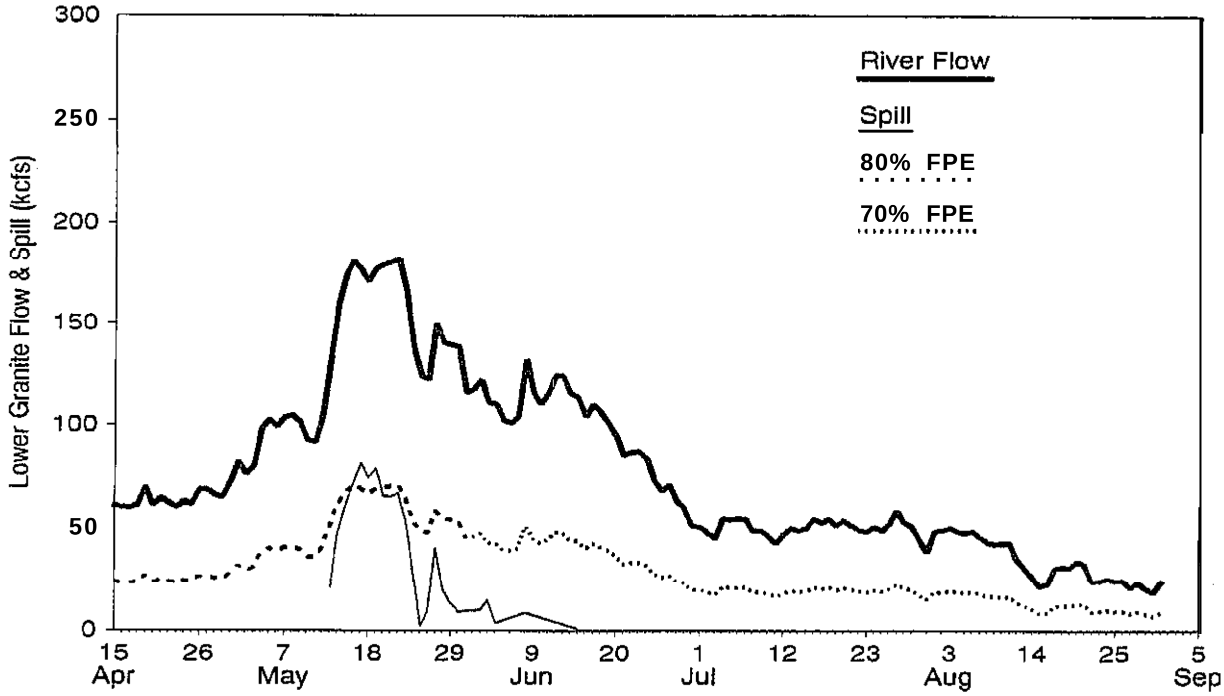


Figure 9. Average daily flow **and** spill at Lower Granite Dam in 1993, compared to the levels needed to achieve the **80/70** Fish Passage Efficiency **(FPE)** request.

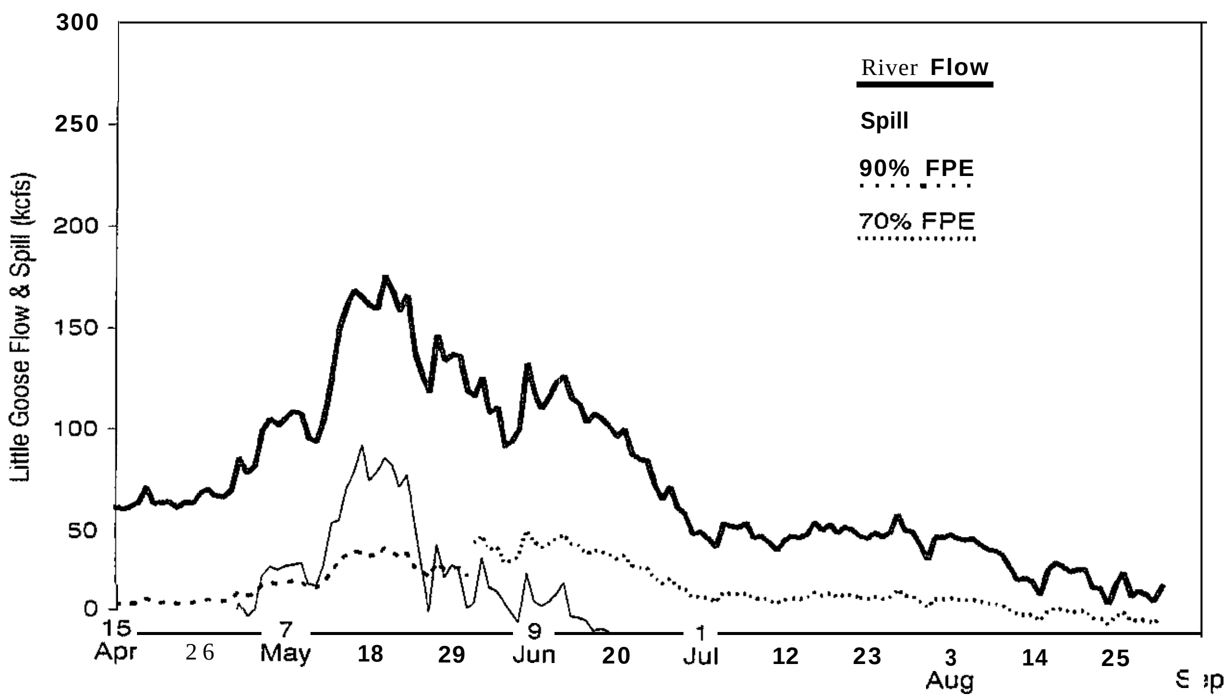


Figure **10.** Average daily flow and spill at Little Goose Dam in 1993, compared to the **levels** needed to achieve the **80/70** Fish Passage Efficiency **(FPE)** request.

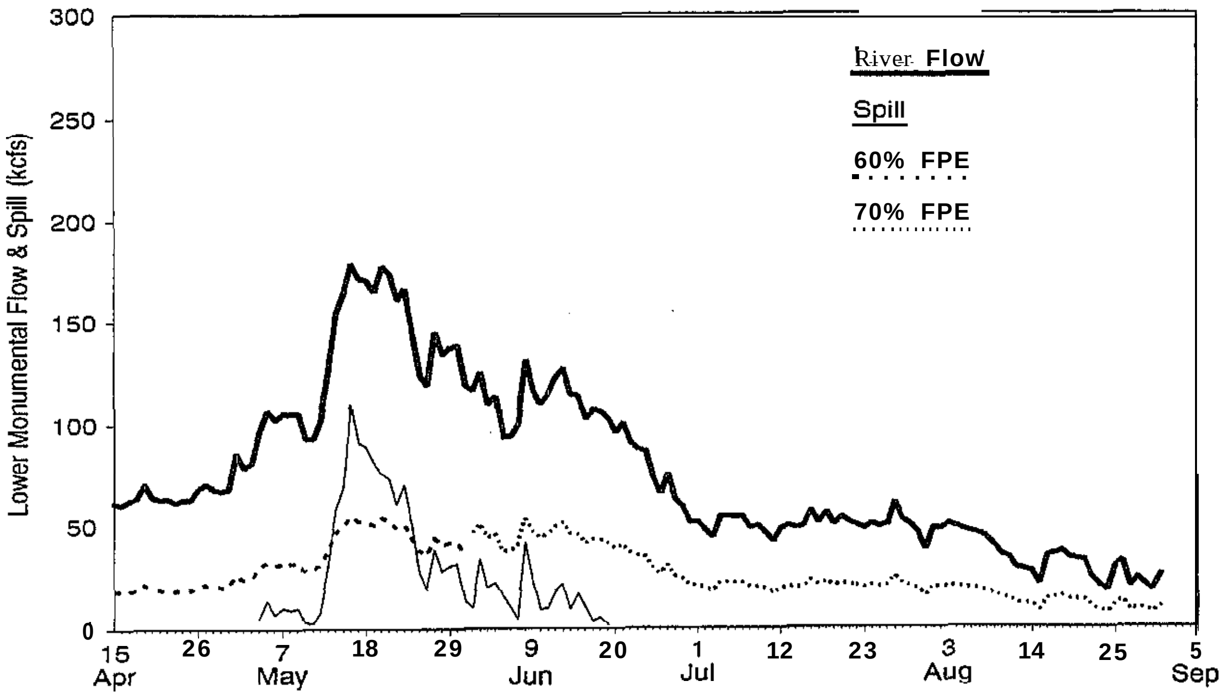


Figure 11. Average daily flow and spill at Lower Monumental Dam in 1993, compared to the levels needed to achieve the 80/70 Fish Passage Efficiency (FPE) request.

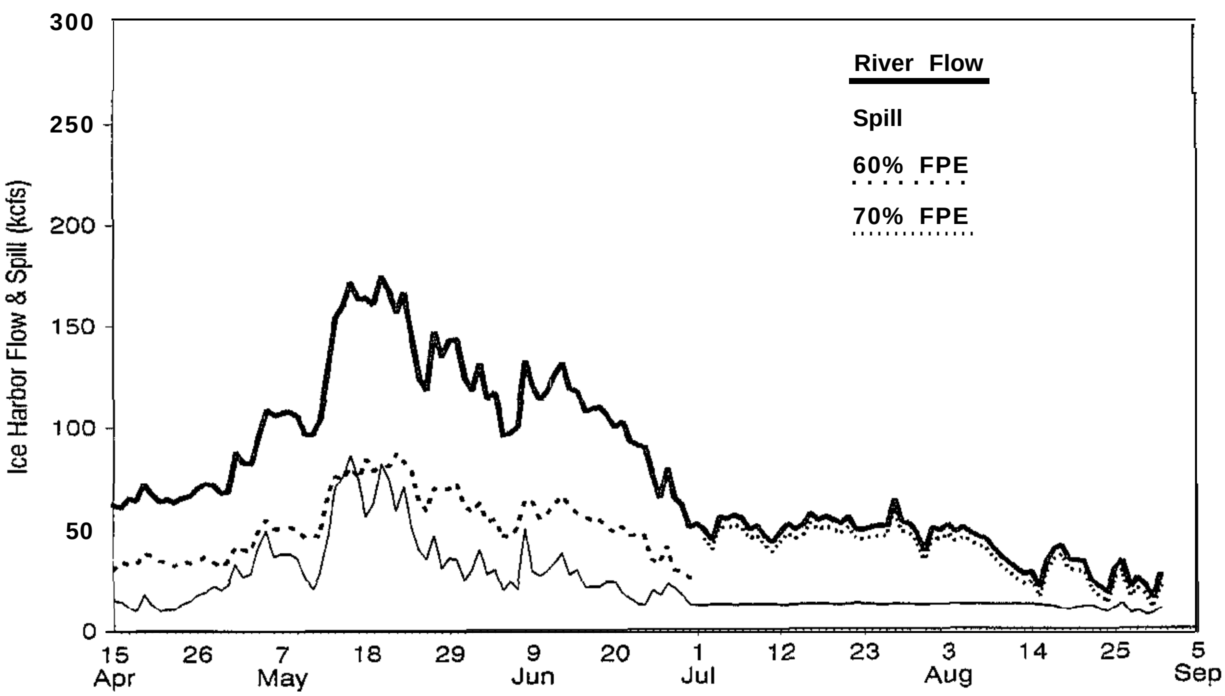


Figure 12. Average daily flow and spill at Ice Harbor Dam in 1993, compared to the levels **needed to** achieve the 80170 Fish Passage Efficiency (FPE) request.

would be given to this untested bypass system. Spring spill was requested by the Fishery Managers as 100% of nighttime flow for 12 hours (1800-0600) from April 15 through May 31. In 1992 the Biological Opinion established spill at Ice Harbor as 60% of instantaneous flow for twelve hours during the spring migration assuming a sluiceway passage of 43 % and approximately a 70% FPE objective. The COE's FPP stated that spill would equal the amounts recommended in the Spill MOA (the negotiated 25 % of instantaneous for 12 hours).

On Friday, April 16 at 1700 hours the spill program at Ice Harbor Dam was terminated. The decision was made by NMFS, BPA and the COE and was based on hourly readings taken from a dissolved gas monitor placed four miles below the project. The COE argued that they were exceeding the EPA dissolved gas criteria. The Fishery Managers argued that there was no biological evidence to substantiate the need to decrease spill. Flow at this time was about 65 kcfs, daily average dissolved gas readings at McNary Dam were only about 111% and the biological monitoring program showed no evidence of fish with symptoms. In spite of the objections of the Fishery Managers in their attempt to protect fish they were overruled by the federal parties, and spill was terminated. Spill was authorized only as excess to hydraulic capacity. The hydraulic capacity at this time was limited to only four units. A fifth unit was brought into service the first week of May, with the sixth unit brought back on line the following week.

In the time between the initiation of spill and the issuance of the Biological Opinion the COE agreed to spill 30% of instantaneous flow between 1800 and 0600 hours (April 26 response to System Operational Request (SOR) from the FPC). This was later limited to an instantaneous spill of 25 kcfs (April 28 response to SOR). When the Biological Opinion was issued it established the "fundamental" spill for ice Harbor Dam at 25 kcfs from 1800-0600 hours. from April 15 until an analysis of dissolved gas levels and fish condition could be completed by the BPA, COE and NMFS. This analysis was to be completed by May 31, 1993. The federal parties did not fulfill their obligation in spite of repeated requests from the Fishery Managers. To-date no analysis addressing the required elements has been provided regarding this major interruption in fish protection for the listed and non-listed stocks migrating through the Snake River in 1993.

On June 16 the Fishery Managers objected to the recommendation from NMFS/COE that turbine intake screens be removed at the Ice Harbor project. The recommendation was aimed based on potentially deleterious conditions around the sluiceway outfall. The Fishery Managers recommended that the operators adopt a summer spill program after daily average flows dropped to less than 50 kcfs, where Unit 1 would be operated with screens in place at its minimum 1% efficiency range and the sluiceway operated during the daylight hours. (Because of concern regarding the inability to turn the sluice off at night the request was later revised to include gatewell salvage of Unit 1, rather than sluice operation). All flow in excess of Unit 1 was to be spilled during the day and 100% of nighttime flow was to be spilled. The COE rejected the request, not on the basis of biological criteria, but because it asked for more than other programs stated (NPPC, COE, NMFS). The summer spill continued at the reduced levels in spite of the fact that no dissolved gas trauma symptoms were noted in the fish monitoring sample. The screens were not removed. The 1993 spill program (Figure 12) not only fell far short of the 80/70 FPE program recommended by the Fishery Managers, but also fell far short of the approximately 70/50 FPE minimum program established by NMFS in 1992, particularly for fall chinook migrants.

5. McNary Darn

Spring spill was requested as 48% of instantaneous flow from 1800-0600 hours from April 16 through June 6. No planned spill occurred at this project during 1993 because of the project's status as a collector project. Spill in excess of hydraulic capacity and overgeneration spill occurred between May 6 and July 12 in varying amounts (Figure 13). The hydraulic capacity at the McNary projected was limited because two units were fitted with extended length bar screens for FGE testing. When uncontrolled spill increased substantially and concern existed over potential dissolved gas trauma, the restrictions on the use of these units was lifted.

Summer spill was requested as 62% of instantaneous flow during nighttime hours (1800-0600) from June 7 through August 31. No planned spill occurred at the project during the summer of 1993.

6. John Day Dam

The Fishery Managers requested spring spill at this project equalling 33 % of instantaneous flow for twelve hours. The 1992 and 1993 Biological Opinions only required implementation of Spill MOA levels at this project. This translated to no planned spill for the spring migration and a spill level equal to 20% of instantaneous flow for ten hours (2000-0600) from June 7 to August 22, while the Fishery Managers recommended a level of 69%. Some uncontrolled spill occurred during the spring migration (Figure 14). Spill outside of the peak of uncontrolled spring flows was as described in the Spill MOA. Some problems with fish descaling and mortality were experienced at John Day this year that were related to the high debris load accumulated in front of the projects. Spill was implemented by the COE, but at a level less than that requested by the Fishery Managers.

7. The Dalles Dam

The Dalles Dam is treated in the same way as John Day Dam in the Biological Opinion and the COE's FPP. The nominal levels of spill negotiated in the MOA call for 10% of daily average flow to be spilled during the spring and 5 % of daily average flow to be spilled during the summer. The Fishery Managers requested that spill be provided as 40% of instantaneous flow based on project limitations associated with higher flows. These limitations were based on physical model simulations conducted at the WES model facility. Outside of the peak in uncontrolled run-off, spill occurred according to the MOA (Figure 15).

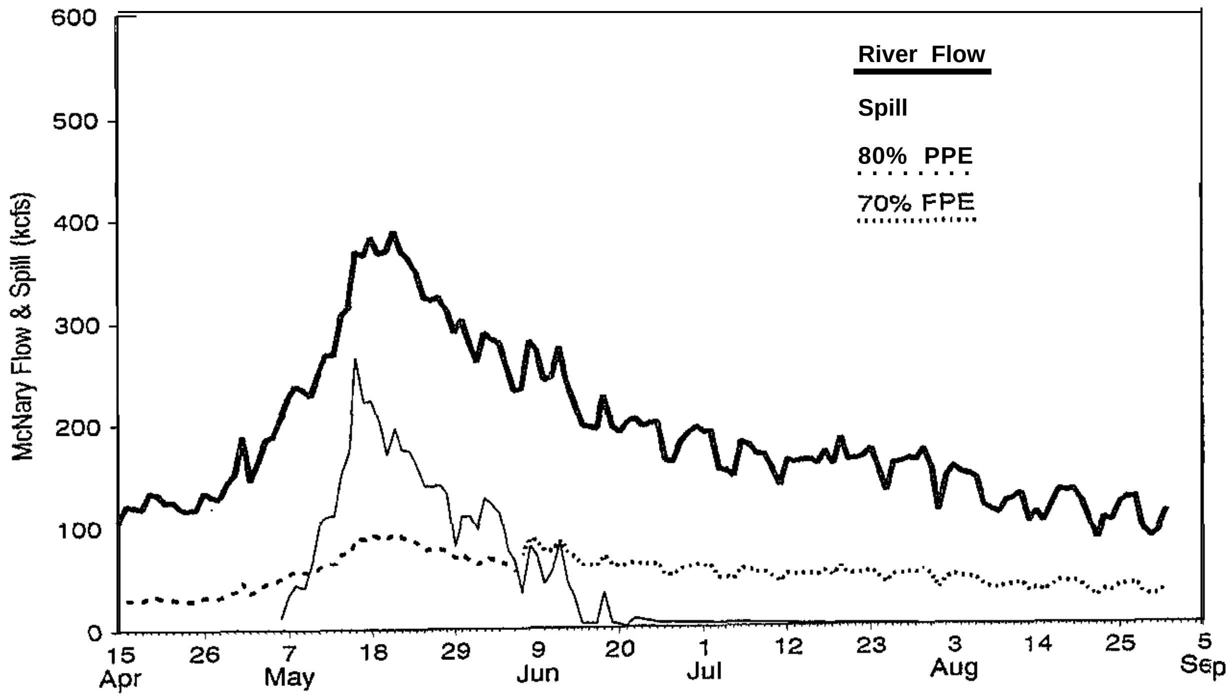


Figure 13. **Average daily flow and spill at McNary Dam in 1993,** compared to the levels needed to achieve the **80/70** Fish Passage **Efficiency (FPE)** request.

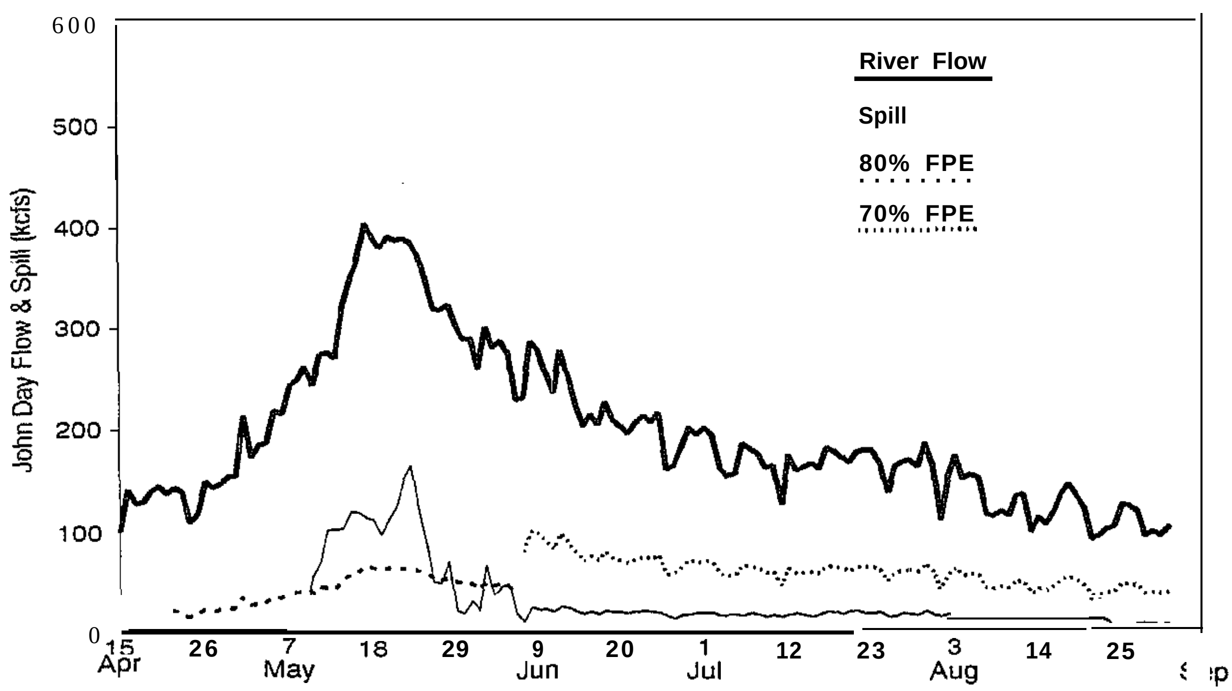


Figure 14. **Average** daily **flow** and **spill at John** Day Dam in 1993, compared to the levels **needed to** achieve the **80/70** Fish Passage Efficiency **(FPE)** request.

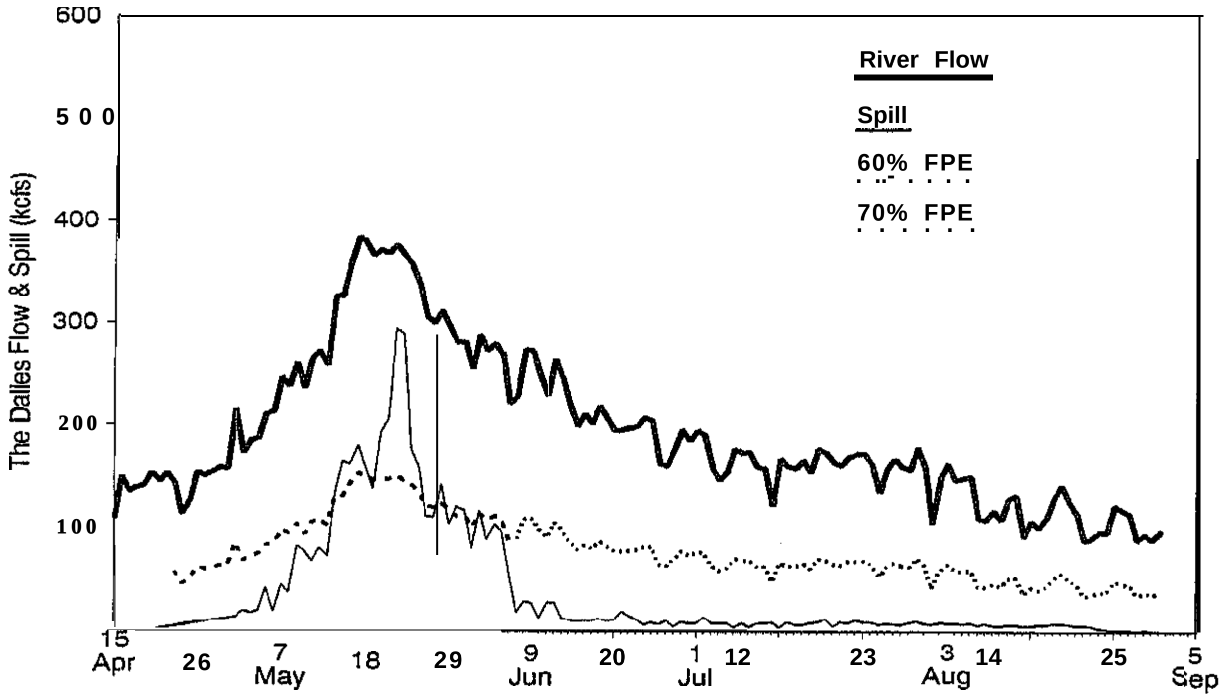


Figure 15. Average daily Row and spill at Tbe **Dalles** Dam **in** 1993, compared to the levels needed to **achieve** the **80/70** Fish Passage Efficiency **(FPE)** request.

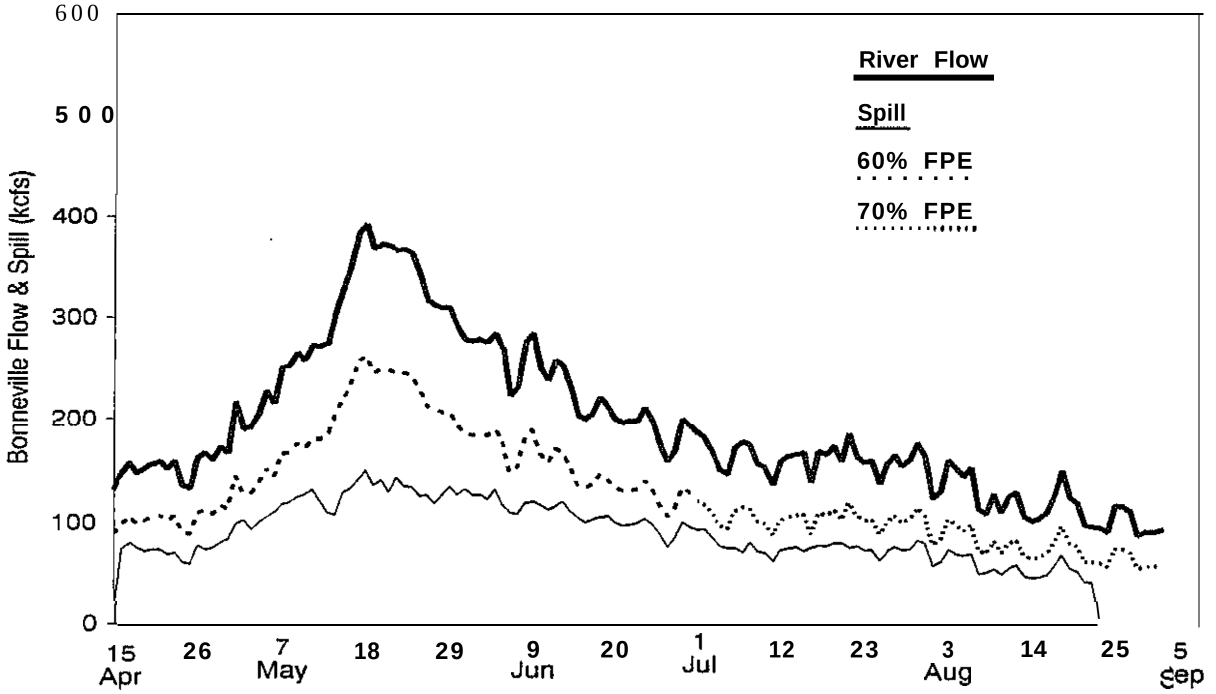


Figure 16. Average daily flow and spill at **Bonneville** Dam in 1993, compared **to** the levels needed to **achieve** the **80/70** Fish Passage Efficiency **(FPE)** request.

The conduct of FGE tests at The Dalles resulted in several instances where spill fell short of the MOA targets during the summer migration, The COE and BPA argued that they had "on average" provided the levels stated in the MOA. These averages calculated by the COE/BPA included the high uncontrolled spill period. The COE did agree, however, after much input from the Fishery Managers that they would "try diligently to provide the MOA target spills on a daily basis".

8. **Bonneville** Dam

In February of 1993 the Fishery Managers commented to the COE regarding their proposed operation of Bonneville Dam during 1993. It was apparent that the Fishery Managers did not agree with the recommendations that the COE suggested, or with the data used to justify the recommendations. The Fishery Managers requested that the COE spill 67% of instantaneous flow at this project during the spring to achieve the 80% FPE. The COE only agreed to spill to achieve the 70% FPE. On May 12, 1993 the COE unilaterally decided, on the basis of dissolved gas concerns, to limit daytime spill to 75 kcfs and nighttime spill to 185 kcfs, instantaneous. On May 14 the spill caps were increased because of the increase in flow. They were increased from 185 kcfs at night to 200 kcfs and 100 kcfs during the day. There was a caveat to increase nighttime spill to 220 kcfs if necessary during high water conditions. The spill caps remained in effect throughout the remainder of the spring migration and precluded achieving the 70% FPE during this period (Figure 16).

On June 24 the FPC submitted an SOR requesting summer spill operations at Bonneville Dam. The request specified a 65% instantaneous spill level to achieve the 70% FPE for summer migrants. The Fishery Managers strenuously objected to the removal of the turbine intake screens at this project. Spill was only provided at a level to provide a 50% FPE. The remainder of the fish passed through the turbine units, with the exception of a few fish that volitionally entered the bypass system.

C. Dissolved Gas **Supersaturation**

Dissolved gas supersaturation and its effects on anadromous fish in the Columbia River Basin was a critical issue in 1993. High flows in the Snake and Columbia rivers forced more uncontrolled spill than has occurred during the past low flow years and led to high dissolved gas supersaturation levels. In addition, with the listing of Snake River chinook and sockeye under the Endangered Species Act, the system bore closer scrutiny than in past years, and the new responsibilities of the National Marine Fisheries Service with respect to in-season management were in the process of being worked out. The recommendation of the regional fishery management agencies and tribes to provide spill sufficient to ensure 80% spring and 70% summer FPE was criticized as potentially causing damage to fish. Partly in response to this criticism, a system wide monitoring plan for tracking the effects of dissolved gas on migrating juvenile salmon and steelhead trout was implemented in 1993. In a letter from J. Donaldson, of the Columbia Basin Fish and Wildlife Authority, to Major General E.J. Harrell, of the COE North Pacific Division, dated February 5, 1993, the agency and tribal plan to monitor smolt condition for gas related problems was described. Their goal was to combine observations of external symptoms of Gas Bubble Trauma (GBT) with dissolved gas monitoring in order to begin the development of the baseline necessary for dissolved gas management in the Columbia and Snake river systems. This in-season management role was not recognized by the COE, who on several occasions disregarded the advice of the agencies and tribes with respect to managing spill to provide the safest migration conditions for fish, particularly at Ice Harbor and Bonneville dams. The COE instead relied on consultations with NMFS in justifying their actions.

The smolt monitoring program observed some impacts on juvenile fish from the high dissolved gas levels that occurred during the period of peak flows in the latter part of May. Daily average total dissolved gas (TDG) saturations exceeded 120% for one to twelve days at all monitoring stations (where data were available) except Lower Granite Dam. The highest levels of daily average dissolved gas recorded were at Lower Monumental Dam, where 130% was exceeded for 4 days (May 17-20), and an instantaneous high (one hourly reading) of 141% was observed. Saturations at John Day, The Dalles and Bonneville exceeded 125% for one to two days. Unfortunately, reliable dissolved gas data were not always available, and several stations, including Ice Harbor, Priest Rapids. McNary North shore and Warrendale, were out of service during the high flows in the last two weeks in May. Dissolved gas measurements from Rock Island and Rocky Reach dams were unavailable for most of the spring migration.

During the period when the highest dissolved gas saturations occurred. low incidence of mostly mild external signs of GBT were observed on juvenile migrants. Most observations were of bubbles in less than 50% of the caudal fin, typically one of the first visible signs of GBT. The largest proportion of juveniles affected was observed at Lower Monumental. where 18.6% of the sample had signs of GBT on one day, on May 20. With the exception of Lower Granite Dam, where no external signs of GBT were seen, the rest of the monitoring stations recorded low percentages (typically 1-2%) of the daily sample affected with mild symptoms of GBT for 2 to 19 days out of the spring migration season. Based on smolt monitoring program observations, it is apparent that the impacts of high dissolved gas saturation on fish were minor in 1993. The results of sampling done downstream of Bonneville by the National Marine Fisheries Service also indicated minor impacts.

1. Dissolved gas conditions in the Snake and Columbia rivers in 1993

The levels of dissolved gas supersaturation for water entering into the system. i.e. daily average measurements from the forebays of Lower Granite and Grand Coulee dams. varied throughout the spring migration season. The range was particularly wide at Grand Coulee, where saturation levels fluctuated from around 100% to a high of 127% daily average TDG saturation. Dissolved gas levels in the mid-Columbia reach between Grand Coulee and Wells dams usually did not vary much. and high levels were either maintained when spill was occurring in the mid-Columbia, or sometimes decreased from high levels if there was no spill. Saturation at Priest Rapids Dam was usually somewhat higher than at the upstream dams. The Snake River at Lower Granite was always less than 110% saturated and did not vary much during the season. Therefore, dissolved gas supersaturation increases in the lower Snake River were caused solely by spill at the lower Snake dams.

At the end of April, when collection of dissolved gas data started, mid-Columbia TDG saturation levels varied between 104% and 109%, Snake River levels were between 100% and 103%, and lower Columbia levels were between 102% and 108%, except for the Warrendale site below Bonneville, which recorded levels of 110% to 111%.

During the first two weeks in May, dissolved gas saturation began to increase as flows increased. Priest Rapids in the Columbia, Lower Monumental in the Snake River, and the lower Columbia stations all recorded levels generally above 110%, and neared 120% saturation.

In the last two weeks of May, flows peaked at levels far above those seen in the past several years of drought. Since the high flows exceeded the hydraulic capacity of the powerhouse. high amounts were spilled, and dissolved gas saturation reached the highest levels of the season. In addition, dissolved gas saturation of water coming into Grand Coulee was higher than normal, reaching a daily average high of 127% saturation. This high saturation was maintained through the mid-Columbia reach, although the peak lasted only a day or two at each site (data were not available for Rocky Reach or Rock Island). In the Snake River, high dissolved gas levels were created by spill at the lower Snake dams. At Little Goose, average saturation ranged from 107% to 120%, with five days greater than 115%. At Lower Monumental Dam average saturation reached 133 %, and ten days during this period were above 125 %. In the lower Columbia, most daily averages were greater than 115 %, 120% was exceeded for five to twelve days, and saturations reached a high of 127% for one to two days at all three dams below McNary.

The beginning of June saw a decrease in dissolved gas supersaturation in the Columbia and Snake rivers. although for the first week in the Snake and lower Columbia, levels still ranged between 110% and 120%. Dissolved gas saturation in the mid-Columbia during June stayed mostly under 110%. By the end of June. few daily averages above 110% were observed in the river system.

During periods of high flow there were correspondingly high spill volumes. The spill occurred due to flow in excess of the hydraulic capacity of the powerhouse. or as a result of overgeneration. Overgeneration spill typically occurred during light load hours (nighttime and weekends) when the hydrosystem was nor able to market all the generation it could produce. The excess flow was spilled.

Spill volumes were exacerbated by project operations during 1993. Some projects had hydraulic capacities that were less than usual because of units being out of service, At some projects this was a result of mechanical failures, while at others the reduction in hydraulic capacity was due to the conduct of research projects. Extended length screens were being tested for their fish guidance efficiency at Little

Goose and McNary dams. This caused a limited hydraulic capacity at these projects during most of the high flow periods. The research units were brought back in service during the highest flow and spill period in an effort to decrease dissolved gas concentrations. In addition, at Little Goose Dam equipment related to a research project was located in a spillbay equipped with a flip lip. This caused proportionately more spill to pass through the spillbays without flip lips and concentrated the spill volume into fewer spillbays until the equipment was removed. All of the above conditions contributed to the high dissolved gas levels in the Columbia and Snake rivers in 1993.

2. Monitoring for Gas Bubble Trauma

In 1993, a systematic program for monitoring migrating fish for signs of GBT was implemented at Smolt Monitoring Program sites. Previously, monitoring sites had informally recorded observations of GBT symptoms. In addition, in 1993 the National Marine Fisheries Service sampled salmonids as well as several other species and recorded incidence of external signs of GBT at several sites below Bonneville Dam. The monitoring program showed that in spite of high spill, the observed impacts of dissolved gas on fish were minor. Almost all observations of GBT occurred during the last two weeks of May, the period of peak flows, when several monitoring sites observed low incidence of GBT. Symptoms were generally mild; most observations consisted of bubbles in less than 50% of the surface area of one fin. The daily proportions of the sample visibly affected by GBT were generally well under 5 % and mostly in the range of 1 to 2%. with the exception of Lower Monumental Dam, where proportions were above 5% on four days and on one day 18.6% of the sample was affected (see Appendix H). On a site visit to Lower Monumental Dam on May 18, five dead steelhead were observed in one of the holding raceways (Larry Basham. FPC personal communication), all with gas bubbles in their fins, and concluded that dissolved gas levels were at least high enough to begin causing mortality to juvenile fish. Dissolved gas levels reached higher levels at Lower Monumental than any other monitoring site, exceeding 130% for three out of the four days when more than 5% of the sample had GBT. These high levels, as discussed above, were a function of project operations at Little Goose.

When symptoms were seen on juvenile fish at smolt monitoring sites, higher proportions of steelhead had visible evidence of GBT as compared to salmon. Below Bonneville. in sampling by the NMFS. very few steelhead were sampled, and symptoms were seen most often on coho, even though chinook were sampled in far greater numbers than any other salmonid.

Fish counters at sites noted any observations of adult fish condition that could be related to GBT. The Washington Department of Wildlife reported in a July 21 memo that a few fish were observed with GBT symptoms at McNary, although in most instances it was unclear whether the injuries observed resulted from GBT. They concluded that their observations did not either support or disprove impacts of dissolved gas on adult fish. There were no known observations of GBT in adult spring/summer chinook trapped at Lower Granite Dam and in the Tucannon River in 1993. However, there were a significant number of adult fish seen in 1993 with “head burns”, a condition where a portion of the cranial area is missing skin and often harboring a fungal infection. It is not known whether the head burns result from exposure to high dissolved gas levels or from physical impact, but were clearly related to high flow and spill conditions. Fish with head burns were not observed to have any known visible evidence of gas bubble trauma, such as cutaneous blisters, hemorrhages or distended eyes.

3. The use of dissolved gas standards in 1993

Although the 110% standard for dissolved gas saturations in the Columbia and Snake rivers set by the states and described in an Environmental Protection Agency (EPA) criterion has been in place for over twenty years, it is commonly exceeded, usually due to spill caused by flows in excess of hydraulic capacity of the powerhouses at the dams on the river. In 1993, there was discussion over the appropriateness of using a standard level of dissolved gas supersaturation that, when exceeded, would lead to the curtailment of spill. CBFWA, in a letter to Major General E.J. Harrell of the COE-NPD on February 5, 1993 recommended that the data on fish condition collected by the smolt monitoring program, in conjunction with dissolved gas monitoring, be used to guide in-season decisions concerning spill at each project. They pointed out that use of the 110% criteria has been criticized as inappropriate by reviewers (Weitkamp and Katz, 1980; Ebel *et* al, 1975; and COE, 1986), and is also problematic when considering the fact that dissolved gas levels coming into the system have exceeded 1 10%, and would therefore require the system not to spill at all. In addition, dissolved gas saturation at the Warrendale site. which is used to govern Bonneville spill operations. often exceeds 110% with no spill at Bonneville. The letter also pointed out inconsistency in the criteria, noting that the Bonneville operations document refers to a 120% dissolved gas criterion, while the Fish Passage Plan mentions 110% in the Bonneville section and 120% at the other projects (e.g. The Dalles and John Day).

In 1993, criteria for dissolved gas saturation levels were used by the COE to limit spill for fish passage. The fishery management recommendations made by the agencies and tribes in 1993 were designed to provide the safest conditions for migrant fish and took into consideration the benefits for fish passage provided by spill and the possible detriment caused by higher dissolved gas levels. During May and June, the COE limited nighttime spill at Bonneville Dam based on concern about dissolved gas levels. This limitation was made over the objections of the agencies and tribes. and in spite of their requests to spill sufficiently to achieve 80170% FPE. At that time, flows were on the decrease, there was no evidence that dissolved gas saturation was particularly high, and biological monitoring below Bonneville did not indicate that a major problem existed. The COE did not provide a biological analysis for their action.

The other major example of the use of a dissolved gas criterion to limit fisheries spill was the disagreement surrounding spill at Ice Harbor Dam in 1993. The Biological Opinion (May 26, 1993) submitted by NMFS on the operation of the Federal hydropower system set “fundamental spill for Ice

Harbor Dam .at 25 kcfs from 1800-0600 hours, from April 15 until an analysis of dissolved gas levels and fish condition can be completed by the BPA, COE and NMFS." This action replaced the measure in the 1993 COE Fish Passage Plan which specified 60% spill at Ice Harbor during the nighttime hours of the spring migration. The required analysis of dissolved gas impacts on fish was directed to be completed before May 31, 1993, but this deadline was not met. To this date, no analysis has been circulated. NMFS also required that spill be "managed to minimize periods where gas supersaturation levels exceed 110 percent, unless otherwise requested by NMFS."

On Friday, April 16 at 1700 hours, the spill program designed to provide the approximate 70% FPE standard agreed to by the COE and NMFS at Ice Harbor Dam was terminated by a decision among the COE, NMFS, and BPA. Only spill in excess of hydraulic capacity was authorized. The decision was prompted by concern about exceeding EPA limits after observing some hourly readings below Ice Harbor of greater than 130% (conversation between Margaret Filardo, FPC, and Chris Ross, NMFS, 4/16/93). However, the COE and NMFS had no biological evidence that fish were being impacted to justify their decision, and an examination of the conditions present in the system when the decision was made raised serious questions about whether there was even a remote chance that fish were being endangered.

During that period (Figure 17), flows at Ice Harbor Dam were averaging 60-65 kcfs, and at these flows and high spill levels in the past, evidence of GBT has never been observed at McNary Dam, and had not been observed at McNary in 1993 at that time. Daily dissolved gas averages were not alarming (I 11.2% for 4/15), and research has shown that it is extremely unlikely that levels of 110 to 115 % present a danger to migrating salmonids. To address concerns about possible impacts on adult fish. researchers in the field were contacted and they reported that they never saw evidence of GBT in any of the over 500 adult fish he trapped in 1992 at Ice Harbor during the spill season (Rudy Ringe, Idaho Cooperative Fisheries Unit, personal communication).

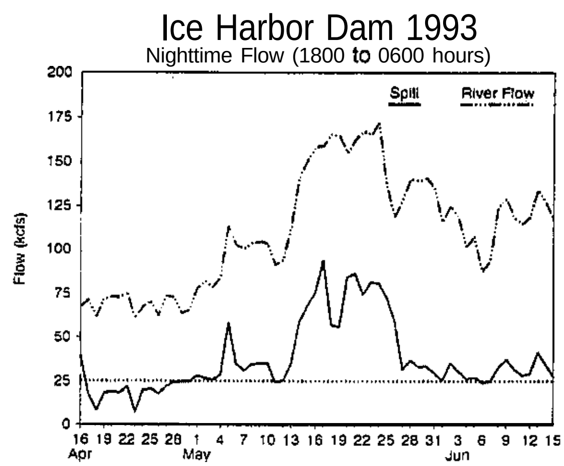


Figure 17. Nighttime flow at Ice Harbor Dam from mid-April to mid-June, 1993.

To remedy the situation, the state fishery management agencies and Indian tribes repeatedly requested that spill be allowed to exceed the 25 kcfs cap to provide 80/70% FPE when dissolved gas conditions were not dangerous for fish as determined by biological observations and saturation data (SORs #93-9, 12. 17. 21 and 42). The COE repeatedly refused to honor the requests, citing their agreement with NMFS to a 25 kcfs cap (letters from B. Tanovan, COE-NPD to M. DeHart, FPC: May 4, 20 and June 30).

In summary, the COE and NMFS made the decision to implement a spill cap at Ice Harbor based solely on a few high hourly readings of dissolved gas at a station four miles below the project, with no biological evidence demonstrating impacts on fish, that had the negative impact of reducing fish passage efficiency at the project. This decision was made over the repeated objections of the agencies and tribes: Although a written justification for this action was requested through the Fish Passage Center by the agencies and tribes, none was received.

D. Discussion

The 1993 spill for fish during the spring migration presented some of the best passage conditions observed in several years. The passage conditions were primarily a result of flows in excess of hydraulic capacity of the powerhouses, flows in excess of generation capacity, and load distribution problems. A low incidence of gas bubble trauma was observed in juvenile anadromous fish during the period of highest flow and spill during the spring migration. The impact of dissolved gas supersaturation was minimal, as evidenced by monitoring results and supported by the fact that based on cumulative passage distributions, there was no indication fish were being eliminated from the system in significant numbers. The high levels of dissolved gas were not necessarily caused by fishery spill, but rather by a combination of overgeneration and excess hydraulic capacity spill. Everything possible was done in the system to decrease the spill level. but in spite of these efforts, substantial amounts were spilled at all projects and concentrations of dissolved gas increased.

The spill levels throughout most of the migration were not at the levels requested by the Fishery Managers for the 80/70 FPE criteria. Implementation of the 80/70 FPE program in a controlled hydrosystem (flows less than hydraulic capacity) is not anticipated to generate the high levels of dissolved gas observed during the spring migration, However, even with the high dissolved gas levels there was little evidence of problems observed in the fish population.

The application of dissolved gas criteria to limit spill for fish passage as occurred at Ice Harbor Dam in 1993 is not appropriate and is not supported by research. Hourly peaks of high dissolved gas have not been shown to be significant in impacting fish: a review of the literature indicates that exposure time is a critical factor and that fish survival is less affected by intermittent exposure as opposed to constant exposure to high TDG sarurations (Dawley et al. 1975, Weitkamp 1976, Weitkamp and Katz 1980). The managemenr of spill to control dissolved gas must address the benefits of spill for fish passage and the potential for adverse impacts from dissolved gas. Biological monitoring along with improved dissolved gas data collection should be used as the basis for determining actions to reduce spill and benefits of spill passage. Lastly, anadromous fish travel time through a reach must be considered because the length of exposure to high levels of dissolved gas is the major factor in determining the impacts the high levels will have on fish. What is unfortunate is that despite the biological data, decisions regarding spill caps were enforced at both Ice Harbor and Bonneville dams.

We anticipate, based on the 1993 experience. significantly high levels of spill can occur with insignificant impacts from gas bubble trauma. while providing for optimal survival of migrating salmonids.

Also of particular concern in 1993 was the recommendation to remove screens and allow fish to pass through turbine units at Bonneville Dam and, although not implemented, Ice Harbor Dam. These decisions were made by the NMFS and the COE based on the Bonneville Survival studies and the predator studies. The Fishery Managers argued that there was a lack of biological justification regarding the removal of the screens. Over the objections of the Fishery Managers, the screens were removed at Bonneville Dam.

In addition, in 1993 the Fishery Managers recommended that spring migrating chinook not be transported and be allowed to migrate in-river under improved flow and spill conditions. These recommendations were ignored and whenever possible. the federal agencies continued to limit spill as mitigation for the operation of the hydrosystem.

E. Historical Summary

The following is a summary description of the spill program over the ten years, 1983-1992. Spill is provided as mitigation at projects to enhance project survival. It is the safest and most benign modes of passage for fish past a hydroelectric project. Historically spill occurred operationally, when project capacity or system generation needs were exceeded. The development of bypass systems by the operators and regulators was an attempt to provide an alternate route of passage by a project, avoiding spill.

As the hydrosystem was developed it became more efficient through such actions as the construction of the DC and AC Intertie transmission lines. As a consequence the occurrence of spill declined, accelerating the disagreements between operators and regulators and the agencies and tribes regarding spill. Negotiations between the operators and regulators and the agencies and tribes resulted in a 10 year package for a spill program (Fish Spill Memorandum of Agreement, December 1988) that was to be provided at projects that were not equipped with adequate bypass systems. As fish stocks declined and the Endangered Species Listings occurred, it became clear that the negotiated contracts were not aggressive enough to recover endangered stocks. The agencies and tribes have re-established the goals originally recommended in the Bypass Performance Standards developed in 1986, and continue to pursue these goals.

Spill Operations over the Water Budget wars. 1983-1992.

1983 - Spill used as a bypass at John Day, Lower Monumental, Priest Rapids, Wanapum. Rocky Reach, and Wells dams. It was also used as a partial bypass at Bonneville, The Dalles, Ice Harbor, Little Goose, Lower Granite and Rock Island dams. At collector projects spill was used to bypass yearling chinook. Transportation was maximized for steelhead. Spill patterns were developed to minimize impacts on adult passage. Dissolved gas concentrations were potentially high and spill was managed for dissolved gas control. High flows in the spring and summer resulted in large amounts of spill. Dissolved gas symptoms were observed in the area below Hells Canyon complex and in the Little Goose bypass and collection system.

1984 - High flows and low loads resulted in large amount of forced spill in the Snake and at McNary. Spill distribution patterns for juveniles and adults were again imposed. Spill was requested at all projects except McNary during the spring chinook migration to maximize bypass. Spill was minimized to allow maximum transport for steelhead. However. high flows resulted in forced spill after the steelhead were migrating and continued throughout much of the spring migration period at each project. The COE developed the 1984 spill plan that was not accepted by the agencies and tribes. They often rejected the biological rationale presented by the agencies and tribes on the basis of the COE's own biological assessment. It was the opinion of the Water Budget managers that the COE should restrict their participation in spill decisions to operational criteria such as flood control, navigation, irrigation and recreation.

1985 - An executive committee process was initiated by the COE since they believed that problems chat had arisen with spill planning in 1984 were due to a lack of policy level involvement. The lack of common objectives precluded the possibility of the group having any impact. Flow in 1985 was considerably lower than had occurred in 1984. The COE implemented a spill plan that they developed to meet the NPPC's 90% survival objective, with the exception of Bonneville Dam where the objective was an 85% FPE. The plan developed by the fishery agencies and Indian tribes was rejected as being too costly. The COE's Juvenile Fish Passage Plan only allowed for spill at Lower Granite and Little Goose dams when flow exceeded hydraulic capacity. Spill at Lower Monumental and Ice Harbor was less than requested by the agencies and tribes, and was managed on a daily basis using hydroacoustic monitoring of fish abundance.

While spill was provided to achieve the 90% survival objective, the standard was objected to by the agencies and tribes since it would not provide protection above a no spill/no bypass alternative at most projects, given the assumptions made in calculating project survival.

1986 - High levels of spill occurred during the spring migration because of high flows from the end of May to June. Requests for spill at the collector projects were denied on the basis of maximizing transportation. Spill at these projects only occurred as excess hydraulic capacity or overgeneration spill. Spill was managed in-season based on trigger numbers established by the COE and coupled with hydroacoustic monitoring. Spill during the summer migration was limited and was not available for the Snake projects, only at The Dalles and John Day. The agencies and tribes developed bypass performance standards that were based on Fish Passage Efficiencies or the percentage of fish that pass a project via non-turbine routes.

1987 - The agencies and tribes began meeting with the COE in December of 1986 to develop a joint

1987 Juvenile Fish Passage Plan. The parties could not come to agreement. In February of 1987 the NPPC amended the Program to require the COE to develop a FPP that incorporated a sliding scale that would provide spill to achieve better than 90% survival, exclusive of transportation, for 80% of the spring and summer migrants at each project in better than critical water years according to a sliding scale. Efforts were hampered by the inability to agree on the slope of the sliding scale and the flow level used to trigger the start of the slide. Efforts resulted in separate COE FPP and an agency and tribal Detailed Fishery Operating Plan (DFOP). Spring spill was only provided at Lower Monumental Dam.

In this extremely low flow year efforts were concentrated on developing a summer spill program for Lower Monumental Dam, which was not equipped with any bypass system. An agreement was reached between the resource agencies and the COE, where the COE would agree to the provision of 15 days of spill over a forty five day migration period. The advantages to the agencies and tribes were that the migration was co be monitored and data would be collected characterizing the passage of fish during the summer months that could be used in future years. Fifteen days of spill was beyond what had been provided in previous years.

In addition. the summer spill agreement was to provide spill at John Day Dam according to a sliding scale whenever BPA was marketing non-firm energy in the system. A similar agreement was established for The Dalles. However, since no non firm energy was sold during the summer period no sliding scale spill occurred at either dam, Spill did occur to achieve the NPPC 90% survival whenever passage indices exceeded 30,000 fish as determined by hydroacoustic monitoring.

1988 - Several processes were initiated prior co the 1988 migration season to facilitate agreement between the hydropower operators and regulators and the agencies and tribes. This included the establishment of the Mainstem Executive Committee (MEC), which was to address major policy controversies that precluded agreement on the 1987 Juvenile Fish Passage Plan. Technical and policy staff tried to reach agreement on a 1988 and long term spill and passage program and Intertie settlement. The agencies and tribes presented a spill proposal based upon the interim 70150 FPE bypass standards. Discussions continued through the fall and wincer on three parallel tracks with policy staff, technical staff and legal staff meeting to address long term spill issues associated with the Intertie expansion development and settlemenr of annual spill controversies. Several proposals were exchanged, including a sliding scale proposal by the agencies and tribes, which was based on flow year and the concept of equitable treatment. The COE. however. developed their own FPP and largely ignored the recommendations of the agencies and tribes. It was apparent chat there would be serious disagreement during the passage season. Spill during 1988 was limited to Lower Monumental Dam during the spring and to Lower Monumental and John Day dams during the summer. The COE again used in-season hydroacoustic monitoring to limit spill to high fish passage days. Spill was provided at Lower Monumental on only 39 days during the spring migration and on only 5 days during the summer migration, Spill was provided on 57 days at

John Day Dam during the summer period of 1988. The agencies and tribes objected to the use of hydroacoustic monitoring as an in-season method for determining the provision of spill.

1989 - The MEC, which was established in 1987 to address major policy issues relating to mainstem fish passage, conducted negotiations from November of 1987 through the fall of 1988 regarding spill for fish passage at federal Snake and Columbia River hydroelectric projects that are not presently equipped with, or have inadequate fish bypass facilities. The culmination of these negotiations was a ten year Fish Spill Memorandum of Agreement (MOA) that commenced on December 31, 1988. In February of 1989, the Northwest Power Planning Council incorporated the spill terms of the MOA into their Fish and Wildlife Program. The COE was not a party to the MOA, and did not endorse the MOA. However, the COE agreed to provide spill as described in the NPPC amendments for the 1989 season and re-evaluate its effectiveness, with the following stipulations: 1) BPA agreed to the power loss; 2) the requested spill was consistent with what was outlined in the amendment: and (3) spill did not cause adverse non-power or safety impacts. The Spill MOA was implemented to the letter during 1989. More planned spill occurred in the system than had occurred in any previous year. The MOA broadened the spill program to include Lower Monumental, Ice Harbor and The Dalles dams during the spring and the above as well as John Day Dam during the summer. Spill was also provided at Bonneville Dam, but not as part of the MOA. During 1989 BPA kept track of spill provided and categorized it as water spilled specifically for fish, or as water that would have been spill because of excess hydraulic capacity or as overgeneration spill. It was apparent that a good portion of the water that was spilled that spring for fish passage was attributable to another reason.

While the spill program during 1989 provided more planned spill than ever before it had to be remembered that this was a negotiated agreement. The spill levels agreed upon were not developed to achieve any biological objective. In fact, at most of the projects these spill levels did not even achieve the interim 70/50 FPE goal of the agencies and tribes.

1990 - The COE again agreed to implement the MOA in 1990. The implementation of the MOA was successful that year. More water was spilled in 1990 than in 1989. Most of that spill came in the form of overgeneration spill and, therefore, the actual cost of the spill program was close to that for 1989. In February of 1990 the CBFWA submitted a recommended operational plan for Bonneville Dam. The plan was based on a reasonable interim objective of a 70% FPE during the spring migration and a 50% FPE during the summer migration, In addition, CBFWA recommended that the second powerhouse not be operated. The proposal called for 49% of average daily flow be spilled during the spring and 44% of average daily flow be spilled during the summer. In 1990 the COE rejected the CBFWA plan and approximately 24% of average daily flow was spilled during the spill season,

1991 - Again. the COE agreed to implement the Fish Spill MOA for the 1991 migration season. The MOA was implemented successfully. In general, spill levels were either at, or above, the amounts specified in the MOA. The high spill levels were primarily a function of the high flows that occurred in the Mid Columbia River, which resulted in a substantial amount of overgeneration spill. Statistics were not kept by BPA allocating spills to either overgeneration or specifically for fish, spills this year. The COE again rejected the CBFWA recommended operational plan for Bonneville Dam. Spill at Bonneville Dam averaged 34% of daily flow over the spill season, in contrast to the 49% and 44% requested for spring and summer. respectively.

1992 - in 1992 spill was implemented as defined in the NMFS Biological Opinion. Spill amounts were increased at the Snake non-collector projects, while in the lower Columbia spill was designated a conservation measure and occurred according to the Spill MOA. In addition to increasing spill levels the NMFS Biological Opinion lengthened the spill seasons. Spill levels determined for the Snake projects were based on the interim 70150 FPE bypass standard. The 70/50 standard was also applied to spill at Bonneville Dam. The agencies and tribes recommendation was for spill to achieve the 80/70 bypass standard. The agencies and tribes maintained that increasing spill in the drought year presented a means of improving fish survival without increasing in flow. The agencies and tribes regarded the NMFS Biological Opinion as establishing minimum spill mitigation for 1992. Requests for increasing spill were denied. Using the same assumptions adopted by NMFS while developing their Biological Opinion, it was estimated that spring spill during 1992 yielded a seasonal 70% FPE at Lower Monumental Dam, a 59% FPE at Ice Harbor Dam, a 58% FPE at The Dalles dam, and 1 70% FPE at Bonneville Dam. No spill was provided at John Day Dam during the spring migration since it was assumed by NMFS that the bypass system provided a 72% FPE. Summer spill in 1992 approximated the 50% FPE objective of the Biological Opinion at Lower Monumental. Ice Harbor. The Dalles and Bonneville dams, but at John Day the FPE was only about 40%. Under direction of NMFS spill was minimized at the collector projects and, in fact, no spill occurred at these projects during 1992.

Summarv

At present, the agencies and tribes view spill as the best means of bypass at all projects. The continued decline of stocks under the spill and passage programs implemented over the past ten years demonstrates the need for more aggressive protection. Spill has been shown repeatedly to be the safest means of passage, to dispel concentrations of predators, and to decrease project passage delay. The preferred implementation is an aggressive spill program, managed in-season to avoid potential impact to adult and juvenile migrants, with a state of the art mechanical bypass system operating to deflect fish from passing through turbine units.

In summary, the present spill program does not achieve the 80% FPE recommendation of the agencies and tribes for passage conditions necessary to the rebuilding of stocks. The evolution of the planned spill program over the past ten years has been one where spill has: 1) purposely been minimized by the operators and regulators for the purpose of collecting fish to maximize transportation; 2) set goals at levels less than those recommended by the agencies and tribes; and 3) decreased spill for fish passage on the basis of dissolved gas concerns, when there has been no biological basis. The sum total of all these actions has probably increased mortality associated with dam passage for in-river migrating salmonids.

IV. 1993 SMOLT MONITORING PROGRAM

A. Monitoring Site Descriptions

Daily information on the status of the smolt outmigration is provided to the Fish Passage Center for in-season Water Budget and spill management needs through the collection of smolts at,monitoring sites in the Columbia River basin (Figure 19). The list of sites and dates of monitoring in 1993 are presented in Table 18. Aspects of monitoring that are unique at each site are detailed in this section. This is intended to provide the reader with a better understanding of the specific data collected at each site.

Table 18. Smolt monitoring sites for 1993.

Site	Method	Data Gathered	Dates of Operation
Snake River:			
Snake River Trap	Dipper Trap	PIT tags,brands,species	3/17 - 7/30
Clearwater R. Trap	Scoop Trap	PIT tags,species	3/24 - 7/30
Salmon R. Trap	Scoop Trap	PIT tags,brands.species	3/20 - 5/12
Lower Granite	Bypass Collection	PIT tags,brands.species	4/15 - 11/01
Little Goose	Bypass Collection	PIT tags.brands.species	4/16 - 11/01
Lower Monumental	Bypass Collection	PIT tags,brands,species	5/4 - 11/01
Mid-Columbia:			
Rock Island	Bypass Trap(PH2)	PIT tags,species	4/1 - 8/31
Lower Columbia:			
McNary	Bypass Collection	PIT tags,brands.species	4/15 - 10/30
John Day	Airlift Pump	PIT tags.brands.species	4/6 - 10/29
Bonneville (PH1)	Bypass Trap	PIT tags,brands.species	3/18 - 11/24
Bonneville (PH2)	Bypass Collection	Brands,species	3/29 - 9/30

1. Snake River Trap

Idaho Department of Fish and Game has operated a dipper trap (Figure 18) on the Snake River at Lewiston as part of the SMP since 1983. The trap is located at the Lewiston-Clarkston Bridge, Snake River Mile 140, immediately upstream from the confluence of the Snake and Clearwater rivers. In 1993, the trap began operation at 1700 hr on March 16 and was forced to stop at 0900 hr on May 14, due to high flows. Sampling resumed at 1400 hr on May 26 and stopped at 1300 hr on June 9, because of mechanical failure.

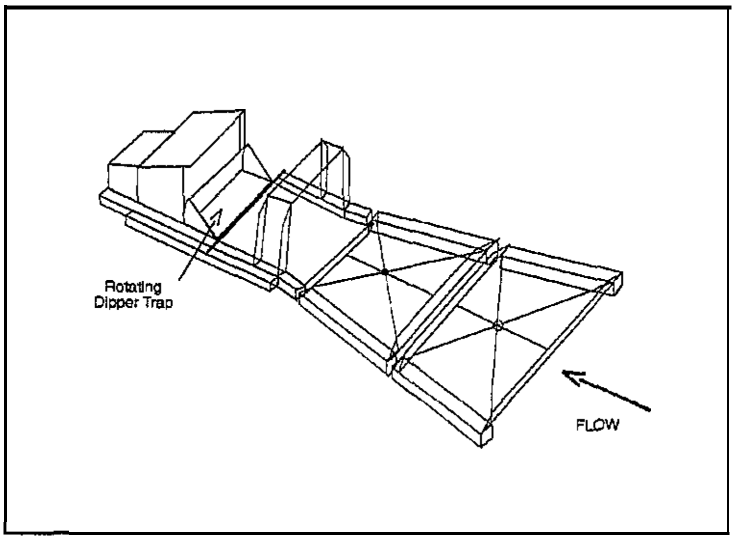


Figure 18. Schematic of a juvenile salmonid dipper trap similar to that used on the Snake River at Lewiston, Idaho.

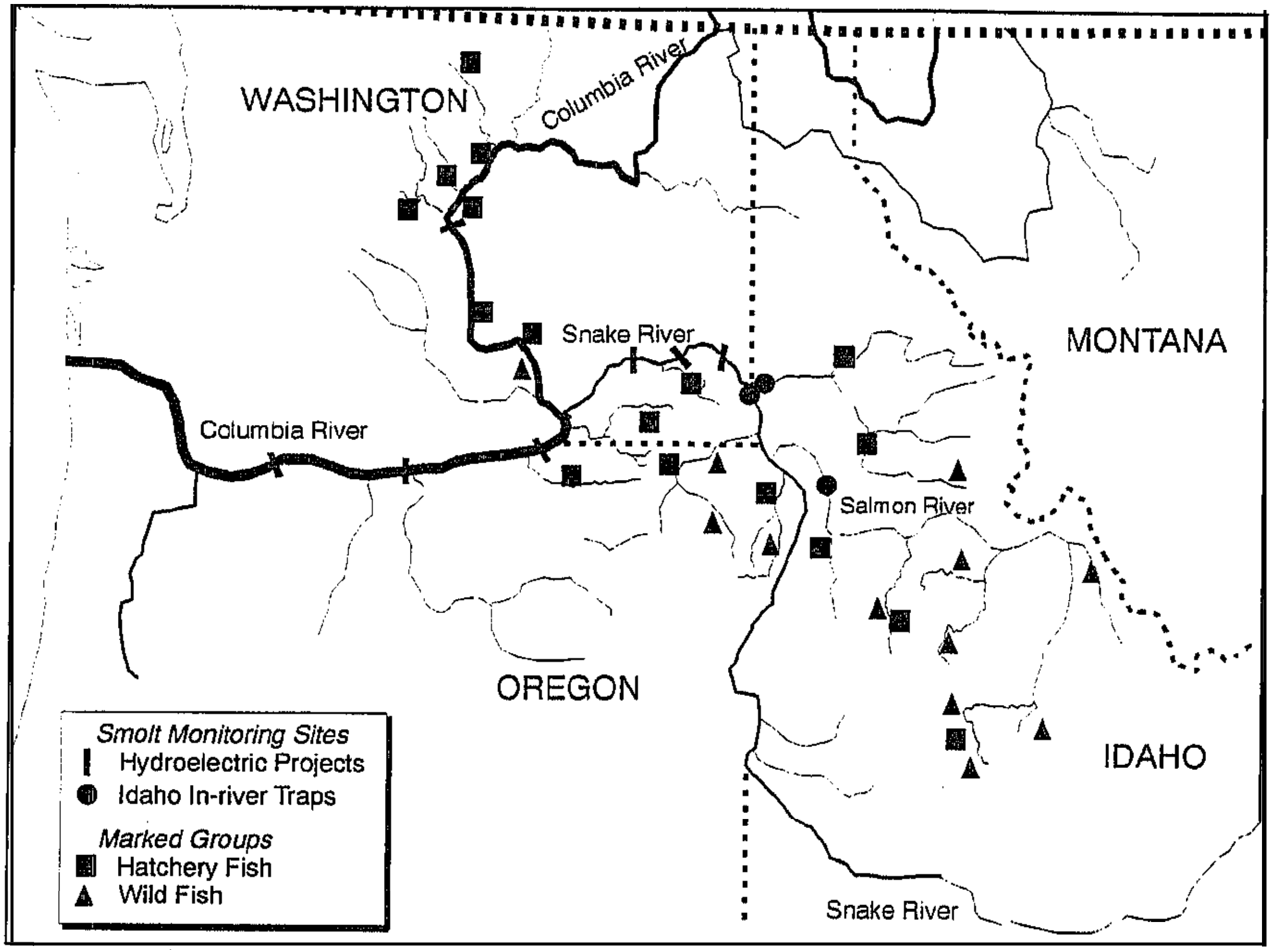


Figure 19. **1993 Smolt** Monitoring Program sites, including seven **mainstem** hydroelectric projects and three in-river traps, and release sites of stocks identified at these sites.

Sampling resumed at 1600 hr on June 15, and continued to 1030 hr on July 30. Fish were collected over a 24-hour period and then enumerated by species. IDFG has released Passive Integrated Transponder (PIT) tagged chinook and steelhead from the Snake River Trap since 1987.

2. Clearwater Trap

Idaho Department of Fish and Game has operated a scoop trap (Figure 22) at Clearwater River Mile 6.1 as part of the SMP since 1984. In 1993, the trap began operation at 1500 hr on March 23 and was pulled from service at 1230 hr on May 4, due to high flows. Sampling resumed at 1600 hr on July 6 and continued to 1200 hr on July 30. Fish were collected over a 24-hour period and then enumerated by species. IDFG has released PIT tagged chinook and steelhead from the Clearwater Trap since 1989.

3. Salmon River Trap

IDFG operated a scoop trap (Figure 20) on the Salmon River at Whitebird for the SMP in 1993. The trap is located at Salmon River Mile 53. This trap site previously provided data for the SMP back in 1987. The trap started fishing at 1100 hr on March 19 and ended sampling at 1130 hr on May 12, due to high flows. Fish were collected over a 24-hour period and then enumerated by species. Chinook and steelhead were PIT tagged and released from this trap.

4. Lower Granite Dam

Sampling for the SMP has occurred at Lower Granite Dam since 1984, and has been contracted to Washington Department of Wildlife since 1987. Lower Granite Dam is located at Snake River Mile 107.5. The project consists of a non-overflow embankment on the north shore, a navigation lock in mid-channel, a spillway, and a powerhouse on the south shore. Figure 21 is a cross-section of the powerhouse Kaplan turbine unit showing screens, gatewell slot and bypass channel. This is the typical layout at Lower Granite, Little Goose, Lower Monumental, McNary, John Day, and Bonneville dams. The bypass/transportation facility is located downstream from the powerhouse. Juvenile salmon in the bypass system are regularly transported from Lower Granite Dam and released below Bonneville Dam. Timed subsamples of the juvenile bypass system were collected during each hour of a 24-hour period (0700-0700 hr), and the number of fish sampled by species was expanded to create a passage index. Monitoring began at 1500 hr on April 14 and ended at 0700 hr on November 1. Freeze branded fish were identified and enumerated by mark.

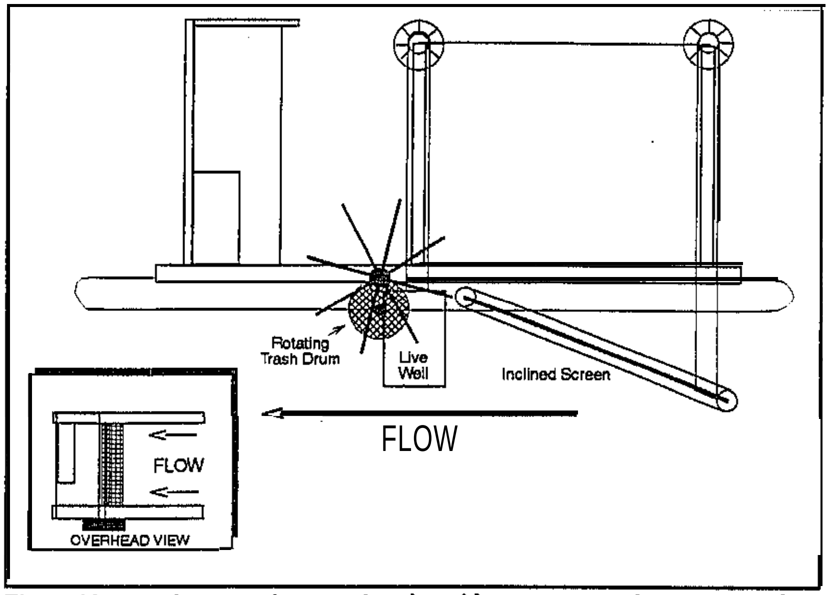


Figure 20. Schematic of a juvenile salmonid scoop trap similar to that used on the Clearwater and Salmon rivers.

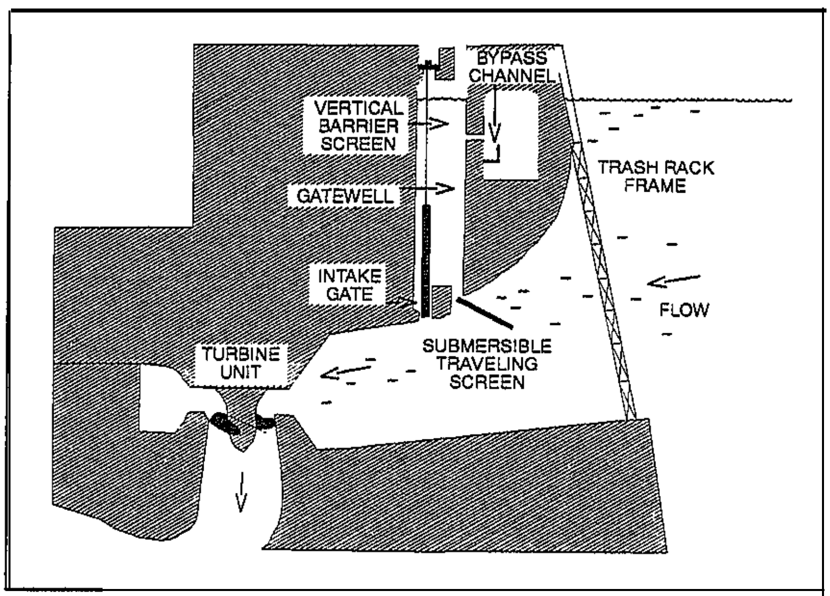


Figure 21. Crossview of Kaplan turbine installation and juvenile salmoni bypass conduits similar to those at Lower Granite, Little Goose Lower Monumental, McNary, John Day, and Bonneville dams.

PIT tag detectors have been permanent components of the Lower Granite juvenile collection system since 1986. They are operated by the Pacific States Marine Fisheries Commission. These detectors interrogate all PIT-tagged fish in the collection system, and the data are loaded to the PIT Tag Information System (PTAGIS).

5. Little Goose Dam

Little Goose Dam is located at Snake River Mile 70.3. The project consists of a non-overflow embankment on the north shore, a spillway and powerhouse, and a navigation lock on the south shore. The bypass/transportation facility is located downstream from the powerhouse. Juvenile salmon in the bypass system are regularly transported from Little Goose Dam and released below Bonneville Dam. Sampling was conducted by Oregon Department of Fish and Wildlife from 0800 hr on April 15 to 1000 hr on November 1. Fish were collected daily and enumerated by species. Freeze branded fish were also identified and enumerated. These numbers were provided to the Fish Passage Center, where they were expanded to provide a passage index.

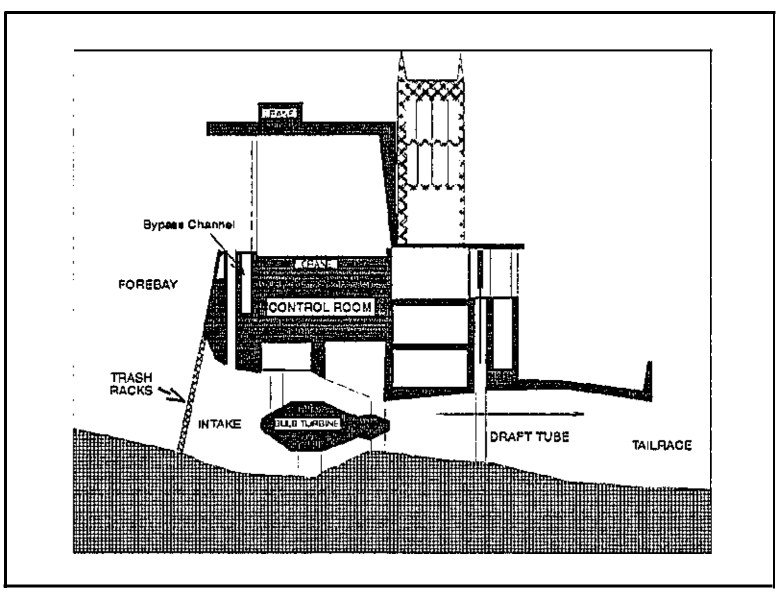
Hatchery chinook and both wild and hatchery steelhead were PIT tagged and released for the SMP between April 26 and May 28. PIT tag detectors interrogate all PIT-tagged fish in the collection system, and have been permanent components of the Little Goose juvenile collection system since 1986.

6. Lower Monumental Dam

Lower Monumental Dam is located at Snake River Mile 41.6. A new bypass/transportation facility was operated this year. Sampling was conducted by Washington Department of Fisheries from 2100 hr on May 3 to 0730 hr on November 1. Fish were collected daily and enumerated by species. Freeze branded fish were also identified and enumerated. These numbers were provided to the Fish Passage Center. where they were expanded to provide a passage index. PIT tag detectors were in place to interrogate PIT tagged fish in the collection system for the first time this year.

7. Rock Island Dam

Sampling for the SMP at Rock Island Dam has been contracted to Chelan County PUD since 1985. Rock Island Dam is located at Columbia River Mile 453.4. The project consists of the original powerhouse on the east shore, a newer second powerhouse on the west shore, and a spillway between the two. Sampling of the second powerhouse for the SMP began at 0900 hr on March 31 and ended at 0900 hr on August 31. Figure 22 is a cross-section of a second powerhouse bulb turbine. The Rock Island second powerhouse is unscreened, so fish enter the bypass system volitionally. Studies have shown that volitional entry into the bypass



gure 22. **Crossview** of bulb turbine installation at Rock **Island** Dam Second Powerhouse.

ranges from less than 1% for chinook to 5% for coho and steelhead. All fish in the bypass system are collected each 24 hours and are enumerated by species. Each species count was expanded to create a passage index. Freeze branded fish were identified and enumerated by mark.

Since 1989, juvenile fish have been PIT tagged and released at Rock Island second powerhouse. Between April 26 and May 29. yearling chinook, steelhead, and sockeye were PIT tagged and released from this site. Subyearling chinook were PIT tagged and released between June 21 and August 13.

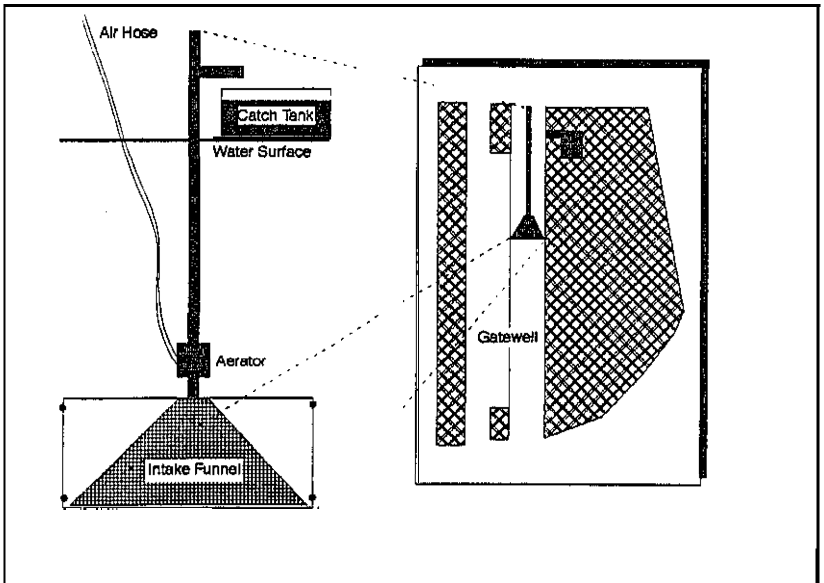
8. McNary Dam

Sampling for the Smolt Monitoring Program has occurred at McNary Dam since 198.5, and has been contracted to Washington Department of Fisheries since 1990. McNary Dam is located at Columbia River Mile 292, approximately 32 miles below the confluence of the Columbia and Snake rivers. The project consists of a powerhouse on the south shore, a navigation lock on the north shore, and a spillway separating the two. The transportation/bypass facility is located at the north end of the powerhouse, midway between the downstream shorelines. Juvenile salmon in the bypass system are regularly transported from McNary Dam and released below Bonneville Dam. Timed subsamples of the juvenile bypass system were collected during each hour of a 24-hour period (0700-0700 hr), and the number of fish sampled by species was expanded to create a passage index. Freeze branded fish were identified and enumerated by mark. Monitoring began at 1700 hr on April 14 and ended at 0900 hr on October 30. From October 30 to November 23. the gatewells at McNary Dam were dipped by WDF. This operation was to enumerate and remove smolts from the gatewells for transportation, since the bypass/collection system was de-watered for construction activities related to the new facility.

Groups of yearling chinook, subyearling chinook, and steelhead were freeze branded at McNary Dam and released back to the river in order to measure migration rates through the John Day reservoir. Steelhead and yearling chinook groups have been similarly marked and released since 1989. Subyearling chinook have been marked and released since 1991. PIT tag detectors interrogate all PIT-tagged fish in the system, and have been a permanent component of the McNary juvenile collection system since 1986.

9. John Day Dam

Sampling for the SMP at John Day Dam has been contracted to the National Marine Fisheries Service since 1985. John Day Dam is located at Columbia River Mile 215.6. The project consists of a powerhouse on the south shore, a navigation lock on the north shore, and a spillway between the two. Monitoring is conducted in Unit 3 using one to two gatewell airlift samplers which guide fish from a gatewell slot into a collection tank (Figure 23). The collection tanks were lifted to the powerhouse deck and drained each hour. The fish in the tanks were routed to a sampling facility where they were enumerated by species. These hourly sample numbers were expanded to hourly and dally passage indices for each species. Freeze branded fish were identified and enumerated by mark, Also, a PIT tag detector, installed on the outfall of the sampling facility, passively interrogated all PIT tagged fish in the sample, Monitoring began at 1000 hr on April 5 and ended at 0700 hr on October 29. Monitoring was suspended at 0700 hr on June 14 to 1600 hr on June 18 for normal maintenance on Unit 3. Between April 5 and May 13 and between June 18 and the end of the season, two airlift samplers in gatewells 3B and 3C were used. Airlift 3C was taken out of service at 1600 hr on May 12 for repairs and was not returned until June 18. Higher than expected mortalities and large numbers of smolts passing John Day Dam precluded the use of more than one airlift, located in 3B, during this period. Annual passage indices and migration timing by species were computed using data from Unit 3B alone. The use of Unit 3B is consistent with all years prior to 1992, the year when Unit 3C was first added.



gure 23. Schematic of the juvenile salmonid airlift sampling system used at John Day Dam.

10. Bonneville Dam

Sampling for the Smolt Monitoring Program at Bonneville Dam has been contracted to the National Marine Fisheries Service since 1986. Bonneville Dam is located at Columbia River Mile 146.1, The project consists of the original powerhouse on the south shore, a newer second powerhouse on the north shore. a navigation lock between the first powerhouse and the south shore, and a spillway separating the two powerhouses. Monitoring at the first powerhouse began at 0700 hr on March 17 and ended at 0700 hr on November 24. Timed subsamples of the juvenile bypass system were collected each hour during a 24-hour period. These hourly samples were enumerated by species and expanded to hourly and daily passage indices. Freeze branded fish were identified and enumerated by mark. A PIT-tag detector, installed on the outfall of the sample trough, also passively interrogated all PIT-tagged fish in the sample. The COE began removing the submersible travelling screens at the first powerhouse beginning July 6; therefore, sampling periods ending July 7 and later will obtain fewer of the passing smolts relative to dates earlier.

Sampling at the second powerhouse occurred three times per week from March 29 through September 30 to determine the amount and extent of descaling.

B. Methods

1. Marking Procedures.

a. Freeze Branding. Hatchery fish to be branded were crowded in the raceway or pond so they could be easily netted, and then placed into a holding tank where they could be supplied to the individual markers. From the holding tank, a sample of fish were then placed into the marking pan or trough containing a mixture of water and anesthetic, generally a buffered solution of tricaine methanesulfonate (MS-222). The marker began freeze branding when the fish were immobile. At McNary Dam. fish from the sampling tank were slowly crowded into an area where they are "pre-anesthetized" before being sent to the marking crews. Marking was accomplished using standard freeze branding techniques which employed silver tipped brass branding rods cooled in a canister containing liquid nitrogen, The brand symbols were transferred to the fish after exposure to the brand tool for ½ to 1 second.

b. PIT Tagging. Collecting and marking fish with PIT tags was accomplished at hatcheries, along stream banks, and at the mainstem sampling sites. Methods of collecting and transferring fish to the marking crews at the hatcheries and sampling sites were similar to those described above for the freeze branding. Fish collected along stream banks were usually transferred to the marking site in buckets and then transferred to the marking pan. The anesthetizing process for fish to be PIT tagged was similar to that for freeze branding. When an individual fish became immobilized, it received a puncture through the musculature near the mid ventral line (fish's belly) with a 12 gauge needle. The needle's push rod then deposited the tag in the fishes body cavity. Two methods of tagging are used in the Basin: a hand-held injection method and an auto injection method. The hand-held method used a syringe which had a disinfected needle, while the auto injector used a stationary needle that was changed every 50-150 tags. In 1993, both tagging methods were used at Rapid River and McCall hatcheries. Downstream recovery data will be compared to determine if detectable differences in survival can be inferred between the two marking methods, at least through their juvenile life cycle.

2. Analysis

a. Smolt Passage Indices. The smolt collection data from each hydroelectric project monitoring site were converted to passage indices, which were used as relative indicators of population abundance, while unadjusted daily fish collection numbers for each species were used at the traps on the Snake, Salmon, and Clearwater rivers. The estimated daily passage index for each species at hydroelectric sites was computed by dividing the daily fish collection estimate by the proportion of flow passing through the sampled unit or powerhouse relative to river flow. This adjustment compensated for different daily project operations (e.g., spill and unit loading) assuming fish passed through spill and powerhouse units in numbers proportional to the flow through these passage routes. At John Day and Bonneville dams, daily passage indices were also computed from the 24-hr sum of hourly estimated passage indices, The passage index was not further divided by any estimate of fish guidance efficiency (FGE), since past FGE estimates have been so variable, both across days within years, and across years of study, For this and other reasons. the daily passage index is not an estimate of absolute daily passage, but does provide a relative measure of how each species' run is progressing over the migration season. Summing the daily passage indices for a particular species over the migration season produced an annual passage index for that site.

Since FGE differs by site and species, the annual passage indices should not be directly compared among sites or among species at a site within a given year. However, annual passage indices can be compared to previous years for a particular species and site, provided they are not considered in isolation of other information. In making comparisons to historical data, the following factors were considered: (1) stability of historic FGE estimates (either fairly constant or following a similar pattern of temporal change within each year); (2) potential FGE improvement due to structural modifications, such as raised bulkhead gates; (3) the magnitude of the annual hatchery releases above a particular monitoring site, by considering a passage index to hatchery release ratio; (4) potential contribution of wild stocks; (5) the magnitude of the transportation program, such as full transportation or a partial bypass mode of operation; and (6) flow conditions.

b. Smolt Passage Tiig. The distribution of daily passage indices for a particular species at a monitoring site provides a measure of migration timing. Plots of the passage distributions for each species at Lower Granite, Rock Island, and McNary darns are presented in Appendix C. In addition, data for weekly ATPase levels (an indicator of smoltification level) are presented in Appendix D.

Estimates of the 10% and 90% passage dates for each species were computed from the cumulative passage distributions at each monitoring site. In order to compute a historic benchmark for comparison, the dates of 10% and 90% passage for each species and monitoring site from available prior years were ordered in an ascending sequence for each percentile, and the median dates from each of these sequences were selected as the historical 10% and 90% passage dates. Changes from the historic migration timing cannot be considered in isolation of other influential factors, such as differences in hatchery release schedules. flow patterns: and project operations,

c. Smolt Travel Time. 1993 travel time estimates (Appendix E) were computed for hatchery and in-river freeze branded (FB) and Passive Integrated Tranponder (PIT) tagged salmonids in the index reaches, as shown in the box below

<u>Snake River:</u>

- Hatchery release sites to Lower Granite Dam (FB/PIT)
- Snake. Salmon, and Clearwater river traps to Lower Granite Dam (PIT)
- Lower Granite Dam to McNary Dam (FB)
- Little Goose Dam to McNary Dam (PIT)

<u>Mid-Columbia River:</u>

- Hatchery release site to McNary Dam (FB/PIT)
- Rock Island Dam to McNary Dam (PIT)

<u>Lower Columbia River:</u>

- Mcnary Damt to John Day Dam (FB)

The hatchery stocks of chinook and steelhead and in-river marking sites were the same as in previous years. with the addition of collecting and marking smolts at the Salmon River trap in 1993. Wild and hatchery yearling chinook and steelhead were captured, marked with PIT tags and released from traps located in the Salmon, Clearwater and Snake Rivers. In addition to hatchery steelhead, all hatchery chinook in the Snake River drainage were adipose clipped for the 1993 outmigration, so distinction was made between hatchery and wild stocks. Hatchery chinook, and wild and hatchery steelhead were PIT tagged and released from Little Goose Dam. Yearling and subyearling chinook, wild and hatchery steelhead. and sockeye were PIT tagged and released from Rock Island Dam. Yearling chinook and steelhead were freeze branded and released from McNary Dam.

Travel time estimates were computed on the basis of freeze brand and PIT tag mark group recaptures. For hatchery releases, a median travel time estimate was calculated as the difference between the release date and time (or median date of release for volitional or multi-day releases) and the median recovery date and time at a monitoring site. For trap and dam releases. travel times were computed for each PIT tagged fish detected from a group, and the group median travel time estimate was obtained from this travel time distribution. Estimates of travel time through the Lower Granite Dam to McNary Dam index reach were computed as the difference between the median date of passage at Lower Granite Dam and median date of passage at McNary Dam for a specific freeze brand group. Median travel time estimates from McNary to John Day were calculated from the distribution of estimated individual travel times for each weekly freeze brand group.

The median travel time estimates for the individual PIT tagged release groups of each species were used in bivariate and multiple regression analyses with flow and physiologically related variables. For the regression analyses. flow was indexed at Lower Granite Dam for the Lower Granite pool index reach, at Ice Harbor Dam for the Little Goose Dam to McNary Dam index reach, at Priest Rapids Dam for the Rock Island Dam to McNary Dam index reach, and at John Day Dam for the John Day pool index reach. Except as otherwise noted, flow was averaged over the period of time from release to day preceding median detection at the downstream site of the index reach *(i.e.* averaged over the time spanned by the travel time estimate). The reciprocal of average flow became a predictor variable in the analyses.

C. Results and Discussion

1. Smolt Passage Indices at Smolt Monitoring Sites.

a. Snake. Clearwater, and Salmon River traps.

It is difficult to characterize the magnitude and timing of runs using collections at the Salmon, Snake, and Clearwater River traps, except by rough measure. because the traps must be pulled during periods of high flow. which often coincide with periods of peak passage. The Clearwater River trap was pulled May 4. resumed operation on July 6. and continued operation through July 30. The Salmon River trap was pulled for the season on May 12. The Snake River trap was pulled during the evening of May 13.

resumed on May 26, broke down June 10 to 15 and June 18 to 28, and ended sampling on July 30.

The traps do provide information on when the smolt outmigrations first get underway from each drainage, as well as provide a location for the PIT tagging and release of active migrants. The wild chinook migration out of the Salmon and Clearwater rivers was well underway by April 6 and 10, respectively, in 1993 (Table 19). These dates do not represent an estimated 10% passage date for the respective populations, since the traps were out of operation a large part of May, but they are indicative of the beginning of the outmigration. Hatchery and wild steelhead outmigrations were well underway about two weeks later at these two traps. Yearling chinook and steelhead were both passing the Snake River trap in greater numbers by the end of April (Table 19). With the exception of sockeye, the Snake River trap collections were higher than in most prior years even though trap operations ended fairly early in May. Only 2 sockeye were collected at the Snake River trap during this sampling period, with only 4 additional sockeye being collected later after sampling resumed on May 26. From 14.0 to 15.4% of the yearling chinook collected at the Snake and Salmon River traps were of wild origin, With most wild and hatchery passage of steelhead occurring generally in May, and the trap outages during most of that month, the proportion of wild steelhead at the Snake and Clearwater river traps may be biased too low.

Table 19. Collection numbers by species, wild composition, and 10% collection dates of the 1993 spring outmigration at the traps located on the Salmon, Snake, and Clearwater rivers.

Trap	Spring Sample Dates	Species	Number Collected (thousands)	Percent Wild Stocks	Dates when 10% Collected	
					Wild	Hatchery
Salmon River	3/20 to 5/12	Yrlg Chinook	33.8	15.4%	4106	4/16
		Steelhead	8.3	11.5%	4122	4/20
Snake River	3117 to 5/14	Yrlg Chinook	17.5	14.0%	4127	4126
		Steelhead	37.1	8.0%	4127	4128
Clearwater R.	3/24 to 5/04	Yrlg Chinook	10.0	3.2%	4110	4109
		Steelhead	10.9	8.1%	4/21	4/21

b. Lower Granite Dam.

Springtime migrants. The 1993 passage indices at Lower Granite Dam were 1.9 million yearling chinook and 7.1 million steelhead (Table 20). Approximately 19.5% of the yearling chinook collected in 1993 were of wild stocks, and 8.2% of the steelhead collected were of wild stocks. Taking into account historical passage and the number of smolts released from hatcheries, these 1993 passage indices exceeded predictions by a healthy margin. The predicted passage index for 1993 using the average historical passage index to hatchery release ratios for pre-1992 years was 1.3 million yearling chinook and 6.0 million steelhead. With similar numbers of steelhead released from hatcheries in 1993 as in 1992, approximately 70% more hatchery steelhead passed Lower Granite Dam this year compared to last. Residualism of hatchery steelhead was not a problem in 1993, as it was last year.

Table 20. 1993 passage indices at Lower Granite, Rock Island, and McNary dams, with ratios of passage indices to hatchery releases above these sites for 1993 and historic years.

Site	Species	Passage index (X1000)	Hatchery release (X1000)	1993 ratio	1992 ratio	Historic ratio
Lower Granite Dam	Yearling Chinook	1,918.2	5,542	0.35	0.23	0.23
	Subyearling Chinook	16.5	n/a			
	Steelhead	7,089.6	9,718	0.73	0.46	0.62
	Sockeye	4.2	n/a			
Rock Island Dam	Yearling Chinook	15.4	5,161	0.003	0.004	0.006
	Subyearling Chinook	16.1	1,832	0.009	0.006	0.021
	Steelhead	10.3	912	0.011	0.018	0.032
	Coho	38.3	524	0.073	0.065	0.087
	Sockeye	16.1	n/a			
McNary Dam	Yearling Chinook	1,883.0	11,587	0.16	0.16	0.18
	Subyearling Chinook	4,279.3	n/a			
	Steelhead	649.6	11,448	0.06	0.06	0.09
	Coho	164.8	524	0.31	0.12	0.21
	Sockeye	1,007.4	n/a			

[a] Historical ratio is based on 8 years (1984-91) for yearling chinook and 3 years (1989-91) for steelhead at Lower Granite Dam; 7 years (1985-91) for all species at Rock Island Dam; and 8 years (1984-1991) for all species at McNary Dam.

The 1993 passage index for sockeyeikokanee at Lower Granite Dam was approximately 4.2 thousand. This sockeyeikokanee level is over double what was observed in 1992. but less than half the previous 8-year average. The number of kokanee flushed out of Dworshak reservoir due to flood control releases in 1993 is unknown,

Summertime miarants. The 1993 passage index (and collection) for subyearling chinook was approximately 16.5 thousand at Lower Granite Dam (Table 20). These fish were classified as fall chinook based on a set of morphological characteristics (body shape, head shape. and eye size). The 1993 fall chinook collection was approximately 175% higher than the 6.0 thousand collected in 1992, and 85% higher than the 8.9 thousand collected in 1991. The 1991 total considers only subyeariing chinook passing Lower Granite Dam after June 25. because of the predominance of subyeariing chinook of spring/summer races showing up during June in that year, and the fact that PIT tagged fall chinook did not begin arriving at Lower Granite Dam until after June 25, 1991. As discussed in a 12/1/93 memo (Appendix B), a much higher proportion of PIT tagged fall chinook were detected at Lower Granite Dam in 1993 compared to the previous two years.

c. Rock Island Dam.

Springtime migrants. The 1993 passage indices for spring migrants at Rock Island Dam are 15.4 thousand yearling chinook, 10.3 thousand steelhead (39.0% wild stocks), 38.3 thousand coho, and 16.1 thousand sockeye (Table 20). The 1993 passage indices for yearling chinook and steelhead dropped 17% and 39%. respectively, from the low passage indices observed in 1992. There was only a slight change in numbers of chinook and steelhead released from hatcheries above Rock Island Dam in 1993 from that of 1992 -- 4% more hatchery chinook and 4% fewer hatchery steelhead. By taking into account historical passage and the number released from hatcheries in the 7-year period from 1985 to 1991, the 1993 passage index of yearling chinook is only half of what would be predicted and the total steelhead passage index is only one-third of what would be predicted. The reason for these lower than expected yearling chinook and steelhead passage indices are the same as given last year: low flows and additional operation of Powerhouse 1 during the migration period. April flows averaged only 54 kcfs, and the first 9 days of May averaged only 87 kcfs, which is much lower than last year. FGE studies were underway this year at Powerhouse 1, which resulted in more flow being diverted away from Powerhouse 2 where the sampling system occurs. The additional operation of Powerhouse 1 may have a relatively large effect on the reduced passage estimated from collections of yearling chinook and steelhead from Powerhouse 2. The 1993 passage index for sockeye (16.1 thousand) was much improved over 1992's record low (2.5 thousand), and was slightly above the level observed in 1991 (15.1 thousand), but it is still well below the historic (1985-91) average of 27.1 thousand.

Summertime mierants. The 1993 passage index for subyearling chinook at Rock Island Dam was 16.1 thousand (Table 20). One-fourth of this annual index was accumulated in a 3-day period (July 1-3) shortly after the 1 .S million fall chinook released from Rocky Reach's Turtle Rock Hatchery, These three days had the highest flows of the summer, averaging 133 kcfs. The only other hatchery release of subyearling chinook in 1993 was the 0.33 million spring chinook release from Entiat Hatchery in mid-May.

The 1993 subyearling chinook passage index was low relative to annual passage indices of prior years, given the hatchery numbers released this year, Although the 1993 passage index to hatchery release ratio was 50% higher than the ratio for 1992, it was 57% lower than the historic (1985-91) ratio, During the historic years, subyearling fall chinook from Wells Hatchery was the predominant hatchery stock. However, because of low production levels for 1993, Wells Hatchery did not release any subyearling fall chinook this year,

d. McNary Dam.

Springtime migrants. The 1993 passage indices at McNary Dam were approximately 1.88 million yearling chinook, 0.65 million steelhead (18.2% wild stocks), 0.16 million coho, and 1.01 million sockeye (Table 20). The yearling chinook passage index is about 0.9 million less than the 9-year (1984-92) average of 2.8 million, but when the numbers of hatchery chinook released above McNary Dam are taken into account, 11.6 million in 1993 versus an average of 16 million in the previous 9 years, the 1993 passage index falls right in line with expectation. Likewise, steelhead and coho passage indices for 1993 do not differ much from past years, Sockeye, on the other hand, had an annual passage index of approximately 1 million, a level that has not been seen since 1985 and 1986. Just last year, 1992 produced the lowest sockeye annual passage index (111,000 fish) of the past 9-year record. Approximately 98% of the sockeye collected at McNary Dam in 1993 were of wild origin. Far fewer hatchery sockeye were collected in 1993 as compared to 1992, 17.0 thousand versus 78.5 thousand, even though hatchery releases were very similar in both years.

Summertime migrants. The 1993 passage index for subyearling chinook at McNary Dam was approximately 4.28 million (Table 20). This level is about 30% lower than that of 1992 and similar to that of 1991. Over one million more hatchery subyearling chinook were released above McNary Dam in 1991 and 1993 than in 1992, but with a larger wild chinook outmigration from the Hanford reach in 1992 than in the other two years, a higher annual passage index for subyearling chinook was observed in 1992 at McNary Dam. Unfortunately, the future returns from the 1992 outmigration may not reflect the greater passage numbers at McNary Dam because of low flows, high temperatures, and large mortalities of subyearling chinook observed at McNary Dam (Wagner and Hillson 1993). As for the 1993 outmigration. the higher flows and lower summer water temperatures should benefit this year's smaller run.

e. John Day Dam.

The 1993 passage indices at John Day Dam were approximately 0.72 million yearling chinook, 0.67 million subyearling chinook. 1.07 million steelhead (17.5 % wild stocks), 0.17 million coho, and 0.27 million sockeye. These cumulative totals for each species are the seasonal sum of the daily passage indices that in turn were 24-hr sums of hourly passage indices for Unit 3B. High flows and spill levels at McNary Dam resulted in more smolts migrating in-river below McNary Dam in 1993 than in most years since 1984. This resulted in higher than usual passage indices at John Day Dam this year, especially for steelhead.

f. Bonneville Dam.

The 1993 passage indices of spring migrants at Bonneville Dam (Powerhouse 1) were approximately 2.25 million yearling chinook, 0.88 million steelhead (29.4% wild stocks), 1.60 million coho, and 0.58 million sockeye. These cumulative totals are based on 24-hr sums of hourly passage indices. These 1993 passage indices at Bonneville Dam are between 2 and 6 times higher than the average of the past S years for each species. As stated for John Day Dam. increased spill passage and bypass at upstream dams due to the high flows in 1993 contributed to the large increase in numbers of smolts being collected at Bonneville Dam's first powerhouse trap this year.

After mid-June, the STS's at Bonneville Dam were pulled. resulting in a lower collection on the subyearling chinook run during the summer months than in past years. In addition, approximately 80% of the subyearling chinook annual passage index occurred before June 1 and consisted of Tule fall chinook from Spring Creek Hatchery's three springtime releases. Therefore, the 1993 subyearling chinook cumulative passage index of 4.3 million must be viewed cautiously as a potential underestimate.

2. Smolt Passage Timing at Smolt Monitoring Sites.

a. Lower Granite Dam.

Hatchery yearling chinook and all steelhead. The 1993 passage timing of hatchery chinook and all steelhead at Lower Granite Dam was centered between late April to mid-May (Table 21). The 10% and 90% dates of passage for hatchery chinook were April 28 and May 17, respectively, only one day different than the dates obtained for the combined chinook run-at-large. The 10% passage date for total yearling chinook (4/27/93) was ten days later than was typical for monitoring in past years. The 90% date (5/18/93) was 6 days earlier than the historical 90% date, but 3 days later than in 1992. The timing of the early part of the total steelhead migration at Lower Granite Dam was similar to prior years (10% date on 4/29/93). Hatchery steelhead's 90% passage date (5/21/93) was almost two weeks earlier than the historical 90% passage date, and a month earlier than the 1992 hatchery steelhead 90% passage date. Wild steelhead's migration timing for 1993 was shifted only one day later than that of hatchery steelhead. Its 10% passage date (4/30/93) was two days earlier than that of 1991, and its 90% passage date (5/22/93) was the same as that of 1992.

As for specific hatchery stocks of chinook and steelhead (Table 22), the median date of passage at Lower Granite Dam occurred first for Lookinggiass Hatchery spring chinook on April 28, followed by spring chinook from Rapid River, Imnaha. and Dworshak hatcheries between May 3 and 6. The next median passage dates occurred for hatchery steelhead from Wallowa, Little Sheep, and Dworshak hatcheries between May 8 and 9. Summer chinook from McCall Hatchery and spring chinook from the late release from Dworshak Hatchery had their median date of passage fall between May 14 and 16. Flows were at or below 100 kcfs around the dates of median passage for all stocks passing Lower Granite Dam before May 10. The McCall and late Dworshak Hatchery smolts had median passage after flow began exceeding 140 kcfs. The median dates of passage at Lower Granite Dam of wild and hatchery summer chinook from the South Fork Salmon River coincided. while that of hatchery spring chinook in the Salmon. Imnaha. and Grande Ronde rivers tended to be about one week earlier than their wild counterparts.

Table 21. Passage dates at Lower Granite, Rock Island, and McNary dams

Site	Species	1993 10%	1993 90%	1992 10%	1992 90%	1991 10%	1991 90%	Historical[a] 10%	Historical[a] 90%
Lower Granite Dam	Yearling Chinook	4/27	5/18	4/16	5/15	4/23	5/20	4/17	5/24
	Hatchery Chinook	4/28	5/17	na	na	na	na	na	na
	Wild Chinook	4/25	5/23	na	na	na	na	na	na
	Subyearling Chinook	6/28	8/26	6/06	7/17	6/11	8/01	na	na
	All Steelhead	4/29	5/21	5/01	6/12	5/04	5/29	4/28	6/01
	Hatchery Steelhead	4/29	5/21	5/01	6/22	5/04	5/29	na	na
	Wild Steelhead	4/30	5/22	4/22	5/22	5/02	5/28	na	na
	Sockeye	5/17	6/23	4/20	6/20	5/08	7/04	na	na
Rock Island Dam	Yearling Chinook	4/27	5/26	4/23	6/12	4/29	6/11	4/22	5/22
	Subyearling Chinook	6/17	7/30	5/29	7/28	6/04	8/09	6/06	8/02
	All Steelhead	5/04	5/27	4/29	5/19	5/05	5/25	5/06	5/31
	Hatchery Steelhead	5/02	5/23	4/29	5/17	5/05	5/22	na	na
	Wild Steelhead	5/08	5/31	4/27	5/24	5/03	6/14	na	na
	Coho	5/19	6/01	5/13	5/26	5/21	6/01	5/13	5/29
	Sockeye	4/26	5/24	4/17	5/17	4/29	5/28	4/19	5/26
McNary Dam	Yearling Chinook	5/04	5/31	4/17	5/28	4/17	6/06	4/23	5/23
	Subyearling Chinook	6/27	8/02	6/19	7/16	6/24	7/31	6/15	7/20
	All Steelhead	5/01	5/26	5/02	6/13	5/01	5/27	4/29	6/02
	Hatchery Steelhead	5/01	5/26	5/04	6/18	5/01	5/26	na	na
	Wild Steelhead	5/01	5/27	4/23	5/28	5/04	5/29	na	na
	Coho	5/06	6/02	5/04	6/01	5/11	6/05	5/16	5/31
	Sockeye	5/08	5/27	5/01	5/25	5/08	5/29	5/01	6/03

[a] Historical percentiles are based on passage data for 7 years (1984-90) at Lower Granite Dam and 6 years (1985-90) at Rock Island Dam.

Wild yearling chinook passage. The migration timing of wild chinook at Lower Granite Dam is available for 1993 from both collection from the run-at-large and from detections of PIT tagged fish. The middle 80% passage dates range from April 25 to May 23 for the wild chinook run-at-large. Detections of PIT tagged fish show the migration timing extends much later into June for many individual wild chinook stocks. The migration timing at Lower Granite Dam of listed wild chinook stocks originating from tributaries of the Salmon. Imnaha. and Grande Ronde rivers is based on the detections of smolts

Table 22. 1993 Migration timing of Snake River drainage hatchery chinook and steelhead at Lower Granite Dam[a].

Release Site	Median Release Date	Median Travel Time	Median Date LGR	Flow[b] (kcfs)
Spring Chinook				
Rapid River H	4/17	17	5/04	92
Lookingglass H	4/07	21	4/28	69
Dworshak H	4/08	25	5/03	87
	4/22	14	5/06	99
	5/06	10	5/16	167
Summer Chinook				
Imnaha H	4/12	23	5/05	90
McCall H	4/03	41	5/14	145
Steelhead				
Wallowa H	4/19	20	5/09	99
Little Sheep H	4/28	10	5/08	100
Dworshak H	5/04	4	5/08	100

Data source: Appendix E, Tables X to XIII, XVI, and XVII.
Flow is 7-day average centered around median date of passage at Lower Granite.

that had been PIT tagged as parr during the summer and fall months preceding the spring outmigration. The middle 80% of the 1993 wild chinook passage distribution at Lower Granite Dam began in late April and ended by late May to mid-June for most listed stocks (Table 23). An exception was wild spring chinook from Frenchman Creek in the uppermost section of the Salmon River, which had a migration timing that was one month later than most other stocks. In general, the 1993 wild chinook migration averaged about two weeks later in 1993 than in 1992, based on PIT tag detections of 16 stocks (Table 23). Milder winter conditions in 1992 compared to 1993 resulted in an earlier runoff and warming of the rivers in that year. Also, higher mortality in 1992 could have truncated the migration distribution that year. In both years, the first 10% of passage occurred at Lower Granite Dam when river temperatures reached around 49-50°F.

Flow levels during May and June were substantially higher in 1993, resulting in better survival conditions and more wild chinook smolts being detected at Lower Granite Dam than in 1992 (Table 24). Recovery percentages of marked wild stocks available in both years in general showed a 10-60% increase in 1993. Some upper Salmon River stocks had about a four-fold increase in PIT tag detections at Lower Granite Dam. Of the 16 stocks observed, there were two groups that showed a reduction in recovery percentages in 1993. It is unclear why these two groups, which had the highest detection percentage in 1992, have lower than average percentages in 1993. With 30-40% spill at Lower Granite Dam during a ten-day block in May 1993, the recovery percentages for 1993 may be conservatively low since only a 1: 1 spill efficiency level was assumed in daily passage expansions.

Sockeye/kokanee. The middle 80% passage timing at Lower Granite Dam of sockeye/kokanee fell between May 17 and June 23 in 1993 (Table 21). The 1993 migration started later than in 1992, but ended around the same time in both years. Six PIT tagged Redfish Lake sockeye were detected at Lower

Table 23. Comparison of 1992 and 1993 passage timing of PIT tagged wild chinook at Lower Granite Dam.

	1992 Passage Dates			1993 Passage Dates			**Temp.(°F)** on 10% passage date	
Site	10%	50%	90%	10%	50%	90%	1992	1993
UPPER SALMON RIVER								
Frenchman Ck	06/01	06/08	06/22	06/01	06/24	07/10	59	57
Alturas Lake Ck	n/a	05/27	n/a	05/13	06/02	06/11	n/a	55
Valley Ck	04/15	05/01	05/27	05/07	05/20	06/02	49	50
EAST FORK SALMON RIVER								
EF Salmon R	04/13	04/21	05/16	04/25	05/06	05/18	49	50
Herd Ck	04/14	04/20	05/10	04/26	04/30	05/18	49	49
MIDDLE FORK SALMON RNER								
Marsh Ck	04/17	05/07	OS/28	04/29	05/15	05/27	50	50
Capehorn Ck	04/12	05/03	05/30	05/08	05/19	06/26	50	50
Bear Valley Ck	04/15	05/02	05/24	04/29	05/17	06/22	49	50
Elk Ck	04/11	05/01	05/28	O5/O2	O5/16	06/11	52	51
Sulfur Ck	04/16	05103	O5/23	04/28	05/16	06/12	49	50
Big Ck	04/22	05/08	06/01	04/25	05/08	05/19	53	50
SOUTH FORK SALMON RIVER								
SF Salmon R	04/12	04/29	05/24	04/29	05/17	06/03	50	50
Secesh R	04/13	04/27	06/01	04/27	05/16	06/16	49	50
IMNAHA RNER								
IhnahaR	04/10	04/21	05/04	04/24	05/14	05/28	52	50
GRANDE RONDE RIVER								
Catherine Ck	04/16	05/01	O5/21	05/06	05/17	06/05	49	51
Lostine R	04/16	04/30	05/11	04/23	05/04	05117	49	49

Granite Dam between May 14 and June 4 (see FPC's 7/30/93 memo to NMFS. Appendix B).

Wild fall chinook. The middle 80% of the wild fall chinook passage at Lower Granite Dam occurred from late June to late August in 1993. The 80% passage dates range from June 25 to August 18 using PIT tagged detections of known fall chinook and from June 28 to August 26 using the collections

Table 24. Wild chinook PIT tag detection percentages at Lower Granite Dam for 1992 and 1993.

Site	1992			1993			Percent Increase '92 - '93
	Release	Detection	Percent	Release	Detection	Percent	
UPPER SALMON RIVER							
Frenchman Ck	561	12	2.1%	541	50	9.2%	332.1%
Alturas Lake Ck	155	2	1.3%	368	20	5.4%	321.2%
Valley Ck	969	33	3.4%	751	33	4.4%	29.0%
EAST FORK SALMON RIVER							
EF Salmon R	669	32	4.8%	842	44	5.2%	9.2%
Herd Ck	311	17	5.5%	223	18	8.1%	47.7%
MIDDLE FORK SALMON RIVER							
Marsh Ck	981	65	6.6%	1000	99	9.9%	49.4%
Capehorn Ck	209	19	9.1%	205	28	13.7%	50.2%
Bear Valley Ck	1043	69	6.6%	1014	84	8.3%	25.2%
Elk Ck	462	34	7.4%	628	51	8.1%	10.4%
Sulfur Ck	210	24	11.4%	712	34	4.8%	-58.2%
Big Ck	1005	56	5.6%	733	74	10.1%	81.2%
SOUTH FORK SALMON RIVER							
SF Salmon R	1028	80	7.8%	993	89	9.0%	15.2%
Secesh R	1013	38	3.8%	327	33	10.1%	169.0%
IMNAHA RIVER							
Imnaha R	759	73	9.6%	922	67	7.3%	-24.4%
GRANDE RONDE RIVER							
Catherine Ck	940	66	7.0%	998	106	10.6%	51.3%
Lostine R	1107	92	8.3%	996	135	13.6%	63.1%

from the run-at large (Table 21). The median date of fall chinook passage for 1993 fell on July 21. This median passage date coincided with what was observed in 1991, and was a month later than in 1992. However, the duration of the middle 80% of the 1993 migration was double what had been observed in the previous two years. As discussed in FPC's 12/1/93 memo in Appendix B. a much higher proportion of fall chinook that were less than 85 mm at time of tagging survived and were detected at Lower Granite

Dam in 1993 compared to the earlier two years. These fish tended to migrate later in the season, and increased PIT tagged fall chinook detections at Lower Granite Dam in July and August of 1993 over that of previous years. Therefore, a much wider segment of the fall chinook population survived and was accounted for at Lower Granite Dam in 1993.

b. Rock Island Dam.

Springtime migrants. The 1993 passage timing of yearling chinook, steelhead, coho, and sockeye at Rock Island Darn was centered between late April and late May (Table 21). The middle 80% passage of yearling chinook and sockeye spanned one month (April 26-27 to May 24-26), steelhead spanned three weeks (May 2 to May 23), and coho spanned two weeks (May 19 to June 1). The middle 80% passage period for wild steelhead lagged about one week later than that for the hatchery counterpart. For the most part, each species' migration was about a week later than in 1992, but several days earlier than in 1991. The historical 10% and 90% dates, based on 6 years prior to 1991, matched the 1992 dates most closely for yearling chinook, coho, and sockeye, and matched the 1991 dates most closely for steelhead. The very low April flows in the mid-Columbia appear to have contributed to the later 10% passage dates for yearling chinook and sockeye.

Summertime migrants. The migration timing of subyearling chinook at Rock Island Dam began after mid-May with the passage of subyearling chinook from Entiat Hatchery, but it was on June 17 that 10% of the subyearling chinook passage occurred. This 10% date averaged about two weeks later than in prior years, but the 90% passage date was within the range of past years (Table 21). The cooler than average water temperatures in April and May could have contributed to the later 10% passage date for subyearling chinook by slowing growth and smoltification development of wild stocks. it wasn't until two weeks after the 10% passage date that 1.5 million fall chinook were released from the Turtle Rock facility upstream of Rocky Reach Dam.

c. McNary Dam.

Springtime migrants. The 1993 passage timing of yearling chinook, steelhead, coho, and sockeye at McNary Dam was centered during the month of May (Table 21). The 10% passage dates were May 1 for steelhead. May 4 for yearling chinook, May 6 for coho, and May 8 for sockeye. These dates for steelhead. coho, and sockeye were close to those of prior years, while the 10% passage date for yearling chinook was around two weeks later in 1993. The 10% passage date for yearling chinook has been typically linked to the early season passage of Ringold Hatchery spring chinook. In 1993, the Ringold Hatchery spring chinook were released April 1-3. which is similar to past years. In past years the median date of passage of this group has been during the first half of April, but in 1993 sampling did not begin at McNary Dam until April 15. Whether or not part of the Ringold Hatchery group passed before sampling began is unknown. But no spike in passage occurred at McNary Dam during the latter half of April when freeze branded Ringold Hatchery chinook were being collected. The computed median date of passage of freeze branded Ringold Hatchery chinook was April 23 (Table 25). This is twenty days after release, a longer time than usual based on prior years. although flows in the Mid-Columbia River averaged only 58.5 kcfs, a level much lower than in prior years. It appears that low April flows, lower than average river temperatures, and a later than average start-up of sampling at McNary Darn all contributed to the later 10% passage date for yearling chinook this year. The 90% passage dates for all spring migrants in 1993 were within the range observed in prior years.

The migration timing of most mid-Columbia River hatchery stocks of spring and summer chinook at McNary Dam centered around mid-May (Table 25). Freeze branded spring chinook from Winthrop and Leavenworth hatcheries had median dates of passage of May 14 and 18, respectively, and freeze branded yearling summer chinook from Wells Hatchery had a median date of passage of May 17. These fish were released between April 15 and 22, and experienced flows averaging 85-89 kcfs. Freeze branded Entiat Hatchery spring chinook, which were released much earlier than other stocks on April 1, had a median date of passage at McNary Dam of May 7. These fish migrated for 36 days to McNary Dam under flows averaging 57 kcfs.

Snake River stocks of hatchery chinook also had dates of median passage at McNary near mid-May (Appendix E, Table XVIII). The recovery of freeze branded spring chinook from Lookingglass Hatchery had a median date of passage at McNary Dam of May 8-11, and that of summer chinook from Imnaha Hatchery had a median date of May 16-18.

The migration timing at McNary Dam of listed wild stocks of chinook and sockeye from the Snake River drainage can be found in the FPC's 7/30/93 memo to NMFS in Appendix B, which shows middle 90% passage dates. In 1993, the 5% passage dates generally occurred early in May, and the 95% passage dates extended from early June into late July. The earliest 95% date (June 7) occurred for stocks in the lower Grande Ronde River, while the latest 95 % passage date (July 24) occurred for stocks from the upper Salmon River drainage. Three PIT tagged Redfish Lake sockeye were detected at McNary Dam between May 22 and June 7 in 1993.

Summertime migrants. The middle 80% of the subyearling chinook run passed McNary Dam between June 27 and August 2 in 1993 (Table 21). This migration period most closely resembled that of 1991. and it was 1-2 weeks later than the migration period of 1992 and of the historical 1984-1990 period.

As in past years. fall chinook from Priest Rapids Hatchery were the first subyearlings to pass McNary Dam in 1993 (Table 25). Median dates of passage of the five staggered (3 days apart) releases of freeze branded fall chinook from Priest Rapids Hatchery ranged between June 30 and July 7. PIT tagged wild fall chinook from the Hanford reach had a median date of passage at McNary Dam of July 8 (Table 25). Because less than 20% of the wild fall chinook in the Hanford reach were of a large enough size for PIT tagging, this median date represents only the early migrants. The Hanford reach fall chinook are expected to be the major contributor to the run passing McNary Dam after mid-July. In addition, PIT tagged fall chinook from the Turtle Rock Hatchery release were passing McNary Dam later in the season: they had a median date of passage of July 27 (Table 25).

Table 25. 1993 Migration timing of mid-Columbia River drainage marked chinook and steelhead at McNary Dam".

Release Site	Median Release Date	Median Travel Time	Median Date MCN	Flow[b] (kcfs)
Spring Chinook				
Winthrop H	4/15	29	5/14	89
Entiat H	4/01	36	5/07	57
Leavenworth H	4/22	26	5/18	86
Ringold H	4/03	20	4/23	59
Summer Chinook				
Wells H	4/19	28	5/17	86
Fall Chinook				
Priest Rapids H	6/15	17	7/02	97
	6/18	12	6/30	98
	6/21	12	7/03	113
	6/24	11	7/05	102
	6/27	10	7/07	116
Turtle Rock H	6/30	27	7127	111
Hanford Reach (wild chinook)	6/09	29	7108	133

[a] Data source: Appendix E, Tables XIV, XV, and XX.
[b] Flow is 'I-day average centered around backcalculated median date of passage at Priest Rapids Dam.

d. John Day Dam

A later starting, but more compact migration timing was observed for spring migrants passing John Day Dam in 1993 compared to prior years (Table 26). The 1993 dates of 10% and 90% passage are based on collections in Unit 3B alone, which was sampled consistently over the entire springtime migration, Unit 3B alone provided the sample for all prior years except 1992, which included the combined collections from Units 3B and 3C. The 1993 dates of 10% passage for yearling chinook, steelhead. coho, and sockeye were about one later than most prior years except 1991. The early part of the migration of steelhead. coho, and sockeye began about the same time in 1993 as in 1991. Both years were characterized by below average water temperatures in the springtime. The 1993 dates of 90% passage were on or before those of prior years for the spring migrants. Flows above 300 kcfs after mid-May in 1993 moved the later part of the springtime migration quickly through the lower Columbia River, resulting in these earlier 90% dates in spite of the later 10% dates that had occurred this year.

The 1993 summertime migration of subyearling chinook closely matched that of 1992 at John Day Dam (Table 26). The dates of 10% passage in both years were about two weeks later than in 1991 or prior years. Both 1992 and 1993. as well as 1989 and 1991, had a mid-August date of 90% passage. (Numerous outages of the sampled unit in 1990 precluded determination of migration timing dates for subyearling chinook that year.) The three years prior to 1989 had 90% passage occurring around September 7. three week later than in more recent years. The result is a shift from a 3-month middle

Table 26. Passage dates at **John** Day and **Bonneville** dams

Site	Species	1993 10%	1993 90%	1992 10%	1992 90%	1991 10%	1991 90%	Historic[a] 10%	Historic[a] 90%
John Day Dam	Yearling Chinook	5/06	6/01	5/02	6/10	4/27	6/07	4/28	5/30
	Subyearling Chinook	6/21	8/17	6/24	8/15	6/06	S/15	6/08	9/07
	All Steelhead	5/08	5/26	5/03	5/28	5/04	5/29	4/26	5/31
	Hatchery Steelhead	5/10	5/26	5/08	5/29	5/05	5/29	na	na
	Wild Steelhead	4/30	5/26	4/23	5/25	4/29	5/29	na	na
	Coho	5/09	5/30	5/02	5/27	5/11	6/04	5/06	5131
	Sockeye	5/16	5/31	5/08	5/27	5/16	6/01	5/10	6/04
Bonneville Dam	Yearling Chinook	4/22	5/28	4/17	5/22	4/22	5/31	4/19	5/21
	Subyearling Chinook "brights"	n/a	n/a	6/14	7/22	6/05	8/05	6/07	7/29
	All Steelhead	5/08	5/26	4/25	5/29	5/09	5/31	4/26	5/31
	Hatchery Steelhead	5/10	5/26	4/26	5/30	5/09	5/30	na	na
	Wild Steelhead	5/04	5/26	4/23	5/28	5/09	6/01	na	na
	Coho	5/05	5/25	4/25	6/03	5/03	6/01	4/27	6/01
	Sockeye	5/17	5/27	5/11	5/31	5/19	5/31	5/11	6/04

[a] Historic percentiles are based on passage data for 4 years (1986-89) at John Day Dam (Unit 3B) for spring migrants and 3 years (1986-88) for summer migrants; and 4 years (1987-90) at Bonneville Dam (Powerhouse 1) for spring migrants and 3 years (1988-90) for summer migrants.
"Brights" at Bonneville Dam refers to subyearling chinook arriving after June 1; this excludes most "tule" fall chinook originating from Spring Creek Hatchery. Determination of dates of 10% and 90% passage for "brights" in 1993 is inappropriat.e since STS's were removed after July 6 during the peak period of subyearling chinook passage.

80% duration to a 2-month duration in recent years. Increased hatchery production in the Umatilla River since 1988 may be contributing to this change in duration because of their closer proximity to John Day Darn than other upriver stocks.

e. Bonneville Dam

The migration timing of spring migrants at Bonneville Dam in 1993 was more similar to that of 1991, while the migration timing in 1992 was more similar to that of the historic years (Table 26). Both 1991 and 1993 had colder than average water temperatures during the springtime migration, and flows at or above 300 kcfs during the latter half of May. Hatchery releases in tributaries around Bonneville pool highly influence the timing of passage at Bonneville Dam. However, in above average flow years, increased numbers of smolts of upriver origin are bypassed and spilled into the lower Columbia River at McNary Dam. This may account for some similarities in migration timing between 1991 and 1993.

No determination of dates of 10% and 90% passage are made for subyearling chinook at Bonneville Dam for 1993. The STS's at Bonneville Dam were removed after July 6, which historically is near or following the peak of subyearling passage. This change in project operation would undoubtedly lower the collection efficiency on the latter half of the migration and result in biased estimates of 10% and 90% passage dates.

3. Travel Tie Estimation

a. Trap Releases

Daily PIT tag releases from the trap sites provided travel time estimation through Lower Granite Reservoir over the range of flow conditions characterizing the 1993 migration year. This is the first key index reach that smolts migrate through. The marking of all hatchery production in 1993 allowed data to be analyzed and compared for the'hatchery versus wild groups. A complete listing of the travel time estimates for the trap releases are in Appendix E. The 1993 hatchery migration was delayed because of ESA permits and, therefore, most hatcheries released their chinook later than usual. The traps had been marking primarily wild fish until the hatcheries released their fish. This means that there were no fish that were directly comparable for the beginning of the migration. This forced the regression analyses to only consider the fish that were migrating during similar time periods. A number of physical, physiological and biological factors were addressed during the regression analyses and are presented in the individual trap discussions. Some comparisons will be made to the 1992 migration and historic data.

The number of daily releases made from each of the traps is directly dependent on the flow conditions. At high flows the traps are generally not operated due to debris loads and safety precautions. Therefore, above certain flows they are removed from their fishing position, and few mark groups were tagged in-river at the highest observed flows during 1993.

Clearwater Trap

A total of 1,620 hatchery chinook and 3 14 wild chinook were marked and released at the trap during 1993. The trap operated from April 9 through May 4, when it was removed due to high water. The trap also fished from July 7 through July 29 during which time 22 wild chinook were tagged. Wild chinook migrated at a slightly faster rate than the hatchery counterparts at a given flow from the Clearwater River trap to Lower Granite Dam The ATPase level (an indicator of smoltification) was used to compare the smohification of the hatchery and wild fish migrating early in the season, In the April 9 sample, ATPase level was only 6.6 units for hatchery chinook, while it was 10.6 units for wild chinook. This may help explain why the travel time estimates early in the migration season were considerably longer for the hatchery fish. A significant relation between yearling chinook travel time and reciprocal of flow was observed with the 1993 data (Table 27; Figure 24a). The predictability of the relation, as measured by R^2 value. was increased significantly (from $R^2=0.31$ to $R^2=0.50$) by the inclusion of the origin variable IO designate a group as hatchery {0} or wild {1}.

Table 27. Travel time models for yearling chinook and **steelhead** in the traps to Lower Granite Dam index **reach, 1993.**

Species	Variable	Coeff	SE	Prob	MSE	R^2
CLEARWATER RIVER TRAP						
Chinook	Constant	-8.852	7.350	0.241	22.986	0.305
n=24	FLOW”	1656.515	533.386	0.005		
Chinook	Constant	-7.185	6.375	0.000	17.238	0.502
n=24	FLOW’	1681.884	461.980	0.002		
	ORIGIN[a]	-5.652	1.958	0.009		
Hat Stld	Constant	4.395	2.852	0.892	2.504	0.240
n=18	FLOW-’	446.861	198.623	0.039		
Wild Stld	Constant	0.848	1.053	0.439	0.220	0.473
n=12	FLOW’	223.603	74.703	0.013		
SALMON **RIVER** TRAP						
Chinook	Constant	-2.323	1.349	0.091	4.966	0.607
n=57	FLOW’	972.691	105.552	0.000		
Chinook	Constant	-17.919	3.318	0.000	3.458	0.731
n=57	$FLOW^{-1}$	1117.076	92.704	0.000		
	LENGTH	0.116	0.023	0.000		
Steelhead	Constant	-4.564	1.225	0.001	3.104	0.657
n=44	FLOW’	889.425	99.183	0.000		
SNAKE **RIVER TRAP**						
Chinook	Constant	-2.505	1.180	0.039	5.550	0.556
n=53	FLOW”	777.670	97.225	0.000		
Chinook	Constant	19.026	I.590	0.000	5.550	0.556
n=53	SERIAL	-0.203	0.025	0.000		
Steelhead	Constant	-0.060	0.307	0.846	0.474	0.602
n=72	FLOW’	267.213	25.991	0.000		

[a] ORIGIN is assigned the value 1 for wild origin and value 0 for hatchery origin,

Fish travelled faster in 1993 than in 1992 and, percent detected as an indicator of survival, they survived the reach at a greater rate. In 1992 travel time estimates ranged from 9.1 to 21.7 days with flows from 74 to 42 kcfs. The percent detected varied between 37 % and 22 % , averaging around 3 1% In 1993, yearling chinook travel time estimates ranged between 6.1 and 22.8 days at flows of 100 to 62 kcfs. The percent detected ranged from 50% to 30% and had an average of 37% (unadjusted for spill passage).

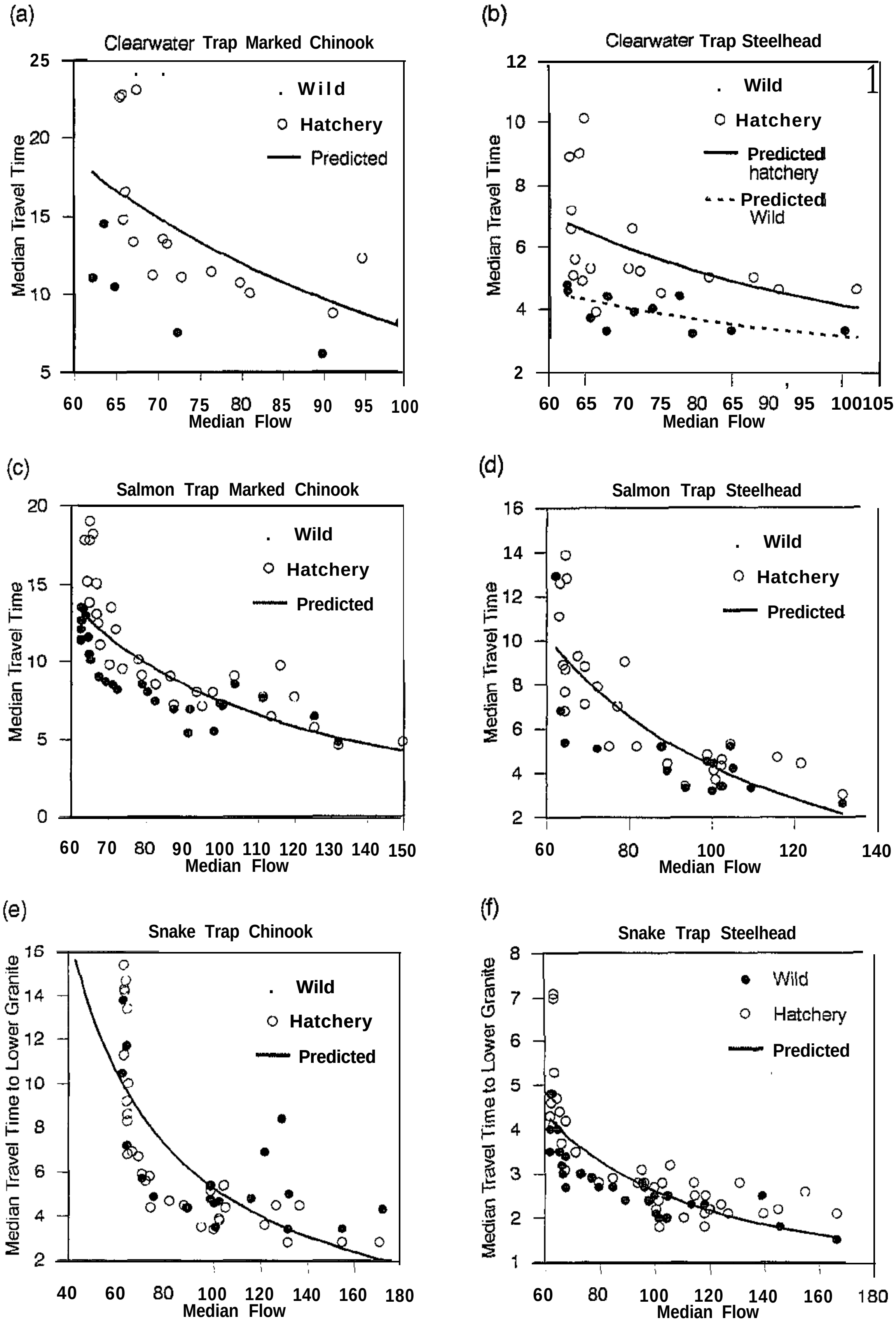


Figure 24 Travel time/flow relations for yearling chinook and steelhead released from the Clearwater River, Salmon River, and Snake River traps in 1993.

A total of 1,100 hatchery and 848 wild steelhead were PIT tagged and released between April 8 and May 4. At a given flow, wild steelhead travelled faster than the hatchery counterparts (Table 27). The predictability of the relation between travel time and reciprocal of flow was greater for wild steelhead ($R^2=0.48$) than for hatchery steelhead (R^2 = 0.24). but the strength of the flow effect (i.e.. slope) was less with the wild steelhead. Both the wild and hatchery relations are depicted in Figure 23b.

Salmon Trap

A total of 3,119 hatchery chinook and 2,158 wild chinook were marked and released from the Salmon River trap between March 26 and May 12. Prior to April 11 only wild fish were caught and released at the trap. Therefore, the comparative analysis between hatchery and wild stocks only included fish marked over the same time period (April 11 to May 12). There was no statistical difference between hatchery and wild stocks with respect to travel times estimated. However, there was a difference between hatchery and wild stocks with respect to length, with the wild stocks being smaller. Travel time at the higher flows from the Salmon Trap to Lower Granite Dam was as fast as 4.6 days with a corresponding migration speed of about I .2 mph. The predictability of the relation (Figure 23c) between chinook travel time and reciprocal of flow (R^2 = 0.61) was increased when length was taken into account (R^2 = 0.73). The smaller (wild) fish were characterized as having faster travel times (Table 27).

A total of 1,638 hatchery and 905 wild steelhead were marked and released from the Salmon River trap in 1993. As with chinook, only wild steelhead were captured and released from the trap between March 30 and April 15. Therefore, the comparative analysis between hatchery and wild stocks of steelhead from the Salmon trap was limited to those fish trapped between April 15 and May 12. when the trap was removed due to high flow. There was no significant difference in travel times estimated between the stocks, and therefore they were analyzed as one group. A significant relation (Figure 23d) between steelhead travel time and reciprocal of flow was observed (Table 27). Steelhead travelled the distance between the Salmon River trap and Lower Granite Dam in as little as 3 days for hatchery steelhead and 2.6 days for wild steelhead at median flows around 130 kcfs.

Snake River Trap

A total of 1,117 wild and 3,189 hatchery chinook were marked at the Snake River trap between April 9 and July 23. The majority of fish were marked between April 9 and May 14, when the trap stopped operating because of high water. The trap resumed operation on May 27, but few fish were captured and released after this date (Appendix E). The regression analysis included fish captured between April 9 and May 30. The late May groups (May 27-30) contained some fish that were labeled as “possible” or “probable” fall chinook. The late May groups were characterized by longer travel times than those chinook that migrated in early May under similar flows (Figure 23e). The analysis of covariance confirmed the homogeneity of slopes and the hatchery and wild chinook were combined for analysis. A significant relation between travel time and reciprocal of flow was obtained for chinook (Table 27). A relation with similar predictive capability was developed using release date rather than flow (Table 27). There was a very high correlation ($r=0.95$) between these two variables.

Flows were much higher in 1993 and the corresponding travel times were much faster than any observed in 1992. In 1992, travel time estimates ranged from 11.6 days at 37 kcfs to 6.4 days at 75 kcfs. In 1993, travel time estimates ranged between 13.4 days at 63 kcfs to 3.4 days at 172 kcfs.

A total of 2,584 hatchery and 2,851 wild steelhead were marked at the trap between April 9 and June 16. Wild and hatchery steelhead showed no difference with respect to travel time and were analyzed together. A significant relation between travel time and reciprocal of flow was obtained for steelhead (Table 27 and Figure 23f).

Historical **Analysis**

The Snake River Trap has been used as a PIT tag marking site for Snake River yearling chinook and steelhead since 1987. The 1987 data was eliminated from a multi-year analysis since (1) the trap collected few fish for marking under the low flow conditions prevailing that year, (2) fish were transported from the Clearwater trap and marked and released at the Snake trap, and (3) few recoveries were made on the groups released, which meant pooling data over several days to generate a median travel time estimate. The 1988-1993 mark data were utilized in this analysis. Those groups of fish from 1988 that were captured at the Clearwater trap and marked and released from the Snake trap were excluded from the analysis. However, fish that were purse seined in the vicinity of the Snake trap were included in the analysis. The travel time estimates generated for chinook and steelhead groups released from the Snake trap between 1988 and 1993 were analyzed for relations with flow and smoltification related factors. Included in the analysis were variables describing:. the average flow from release to the median date of recapture (MEDFLOW or the inverse, FLOW'), year of release (YEAR), average temperature from the day of release to the median date of recapture (TEMP), date of release from the trap (SERIAL), hatchery or wild (ORIGIN), and average length of the release group (LENGTH). All environmental variables were measured at Lower Granite Dam The resulting models are described in the following sections:

Yearling Chinook. The six years of PIT tag releases of yearling chinook from the Snake River Trap covered a wide range of flows. Since trap operation is dependent on flow velocity, the beginning and end dates for marking were variable among the years being considered. To compare consistently released groups representative of the of the majority of the migration over the years studied, the release groups considered were those that were released from April 15 to May 20. In 1993 all hatchery chinook released above Lower Granite Dam were adipose fin-clipped allowing us to distinguish between hatchery and wild fish. However. in previous years a distinction regarding the origin of chinook was not possible. The multi-year analysis includes only hatchery chinook for 1993, since in all other years the groups used for travel time analysis were predominately made up of fish of hatchery origin,

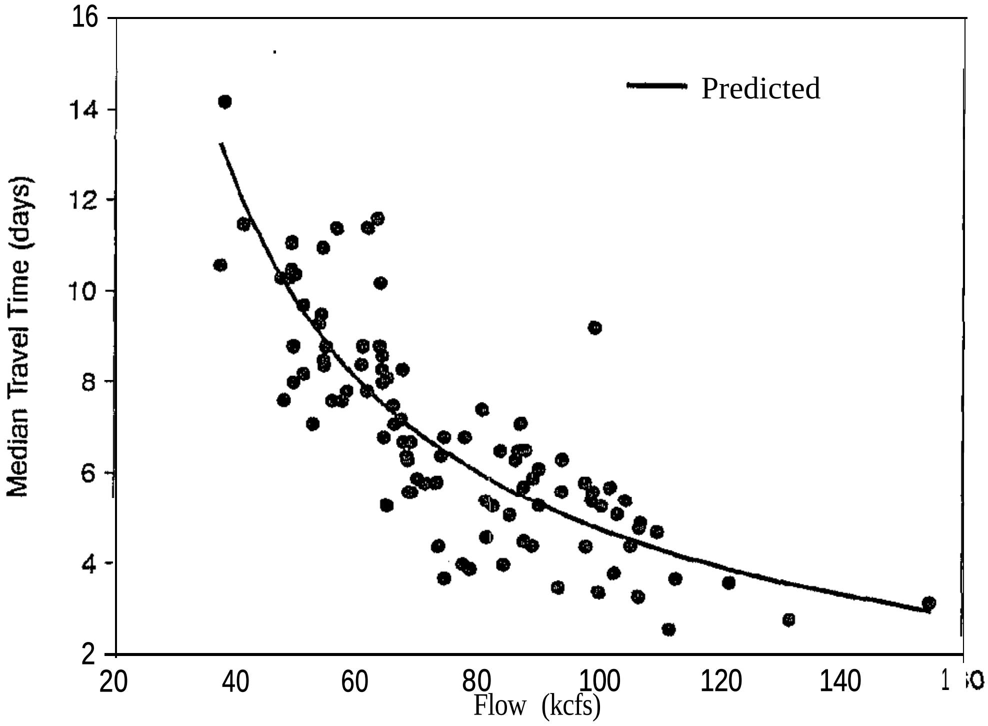


Figure 25. **Snake** River trap chinook travel **time/flow** relations to Lower Granite Dam, 1988-1993.

Three models were developed to explain the travel time estimates. The simple model between travel time and the reciprocal of flow (FLOW-') for the six years of data analyzed yielded an R^2 of 0.694 (Figure 25). This means that 69% of the variability in the median travel time estimate could be explained using the inverse of the flow averaged from the day of release to the median date of recapture (Table 28, Model 1). The predictive capability of the model could be enhanced (R^2 = 0.718) by including a variable that accounted for the year during which fish travelled (Table 28, Model 2). The next question to be asked was whether ail years were significant, or whether the year variable was significant because of one or more years being different. Upon further analysis it became apparent that 1991 was significantly different from all other years included in the analysis. The year 1991 was characterized as having fish with travel times of longer duration than anticipated during April and the first part of May. The migration was late as a result of low flow and below average water temperatures. As flows increased above 100 kcfs by the middle of May the travel time estimates began to decrease.

Because of the distinction associated with 1991 data, a third model was developed which incorporated a variable YR91CODE that assumed a value of 1 for 1991 data and 0 for all other years considered. A model with YR91CODE, FLOW", and TEMP explained over 76% of the variability in travel time estimates among years (Table 28. Model 3).

The Snake River Trap data recoveries of PIT tagged chinook at Lower Granite, Little Goose, Lower Monumental (1993 data only), and McNary dams have been used to develop "minimum survival"

Table 28. Travel time models for PIT tagged yearling chinook released from Snake River Trap, 1988.93.

Model	Variable	Coeff	SE	Prob	MSE	R^2
l	Constant	-0.244	0.503	0.657	1.993	0.694
n = 100	FLOW-'	501.383	33.661	0.000		
?	Constant	0.661	0.572	0.250	1.852	0.718
n = 100	FLOW'	499.036	32.456	0.000		
	YEAR	-0.231	0.079	0.004		
3	Constant	17.236	4.387	0.000	I.582	0.762
n = 100	YR9lCODE	-1.833	0.381	0.000		
	FLOW"	519.189	32.455	0.000		
	TEMP	-0.341	0.084	0.000		

estimates (Buettner 1991). During the time period (1988-1993) that was used for the travel time analyses there were no mechanical structures present at the dams to m-route fish back to the river. Consequently, if a fish was detected in the bypass system then it was removed from the river system and transported. The "minimum survival" estimates are synonymous with cumulative detections and are defined as the total number of PIT tag detections at the projects for each release group expressed as a percent of the release group. If a fish was detected at Lower Granite Dam, or at any project downstream of Lower Granite, then it was assumed that the fish survived to Lower Granite. The difficulty associated with using cumulative detections to represent survival is that there is no way of knowing if the estimate represents minimum survival, "true" survival, or something in-between. The estimate is influenced by project operations (e.g. spill and fish guidance efficiency) which cannot be accounted for easily. Therefore, the utility of the data for addressing changes in survival relative to other variables is limited and must be interpreted within certain bounds.

Several variables were considered in the regression analyses with the cumulative detections including: median travel time (MEDTT), release date (SERIAL), release year (YEAR), flow at Lower Granite at the time of release (RELFLOW or RELFLOW"), average flow at Lower Granite Dam between the 50" and 90" percentile dates of recapture at Lower Granite Dam (FLOW5090 or $FLOW5090^{-1}$), average flow at Lower Granite to the 90" percentile date of recapture at Lower Granite (FLOW90 or FLOW90-'), average temperature from release to the median date of recapture at Lower Granite (TEMP), average spill at McNary between the 10"' and 90"' percentile dates of detection at McNary Dam (MCNSPILL), and the average length of the release group (LENGTH).

The Lower Granite detection rates were initially used to investigate the relation with the variables described. The detection rate at Lower Granite is a function of spill and fish guidance efficiency (FGE) at this project. Spill only occurred at this project during 1993 and the recaptures are expanded for spill assuming a 1: l ratio of fish to spill. However, the recaptures are not expanded for FGE as the estimates for guidance efficiency are variable. The model for the Lower Granite detection rate can be written as a function of the MEDTT, or as a function of the $FLOW90^{-1}$, together with the TEMP variable (Table 29, Models 1 and 2).

A bivariate relation between cumulative detection rate and flow is depicted in Figure 26 ($R^2=0.171$, $n=92$). A model can be developed to explain 34% of the variation in the cumulative detection rate, which incorporates the MEDTT, TEMP and SERIAL variables (Table 29, Model 3). In 1993 considerable spill occurred throughout the Snake River system as evidenced in Figure 27. PIT tagged fish were only detected if they passed through the bypass system at a dam: if they passed by the project in spill then the cumulative detections would be underestimated. The effect of spill is demonstrated by the eight release groups which passed through the system when spill was occurring at all projects. There is no evidence that any mortality was incurred by this group, but that they simply passed through the system undetected. If they are removed from the analysis then the R^2 of the relation is increased (Table 29, Model 4)

Table 29. Detection Rates for PIT tagged yearling chinook released from Snake River Trap, 1988-93.

MODEL	VARIABLE	COEFF	SE	PROB	MSE	R^2
LOWER GRANITE DETECTION RATE						
1	Constant	131.352	19.390	0.000	37.319	0.241
N=100	MEDTT	-1.251	0.262	0.000		
	TEMP	-1.581	0.366	0.000		
2	Constant	123.984	19.674	0.000	39.380	0.200
N=100	$FLOW90^{-1}$	-819.016	201.217	0.000		
	TEMP	-1.389	0.367	0.000		
CUMULATIVE DETECTION RATE						
3	Constant	218.746	23.353	0.000	49.793	0.340
N=100	MEDTT	-1.681	0.344	0.000		
	TEMP	-1.902	0.443	0.000		
	SERIAL	-0.376	0.099	0.000		
4	Constant	197.273	22.055	0.000	40.779	0.363
N=92	MEDTT	-1.907	0.316	0.000		
	TEMP	-1.613	0.418	0.000		
	SERIAL	-0.297	0.091	0.002		

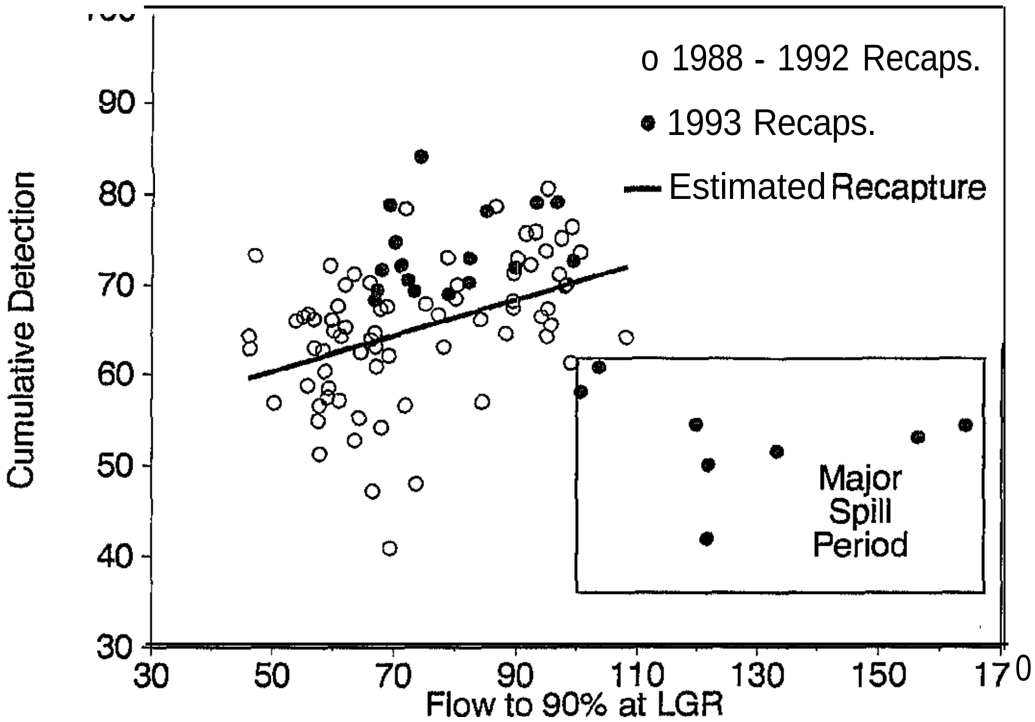


Figure 26. Cumulative detections at Lower Granite, Little Goose & McNary dams of chinook released from the Snake River trap from 19884993.

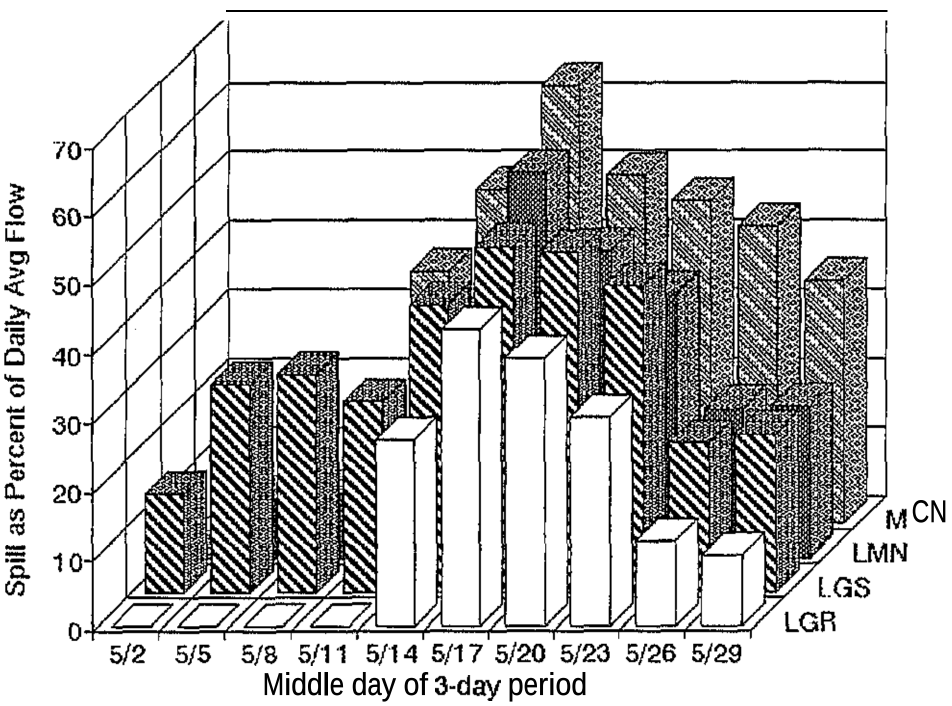


Figure 27. Spill as a percent of dally average flow at Snake River PIT tag detector projects during May 1993.

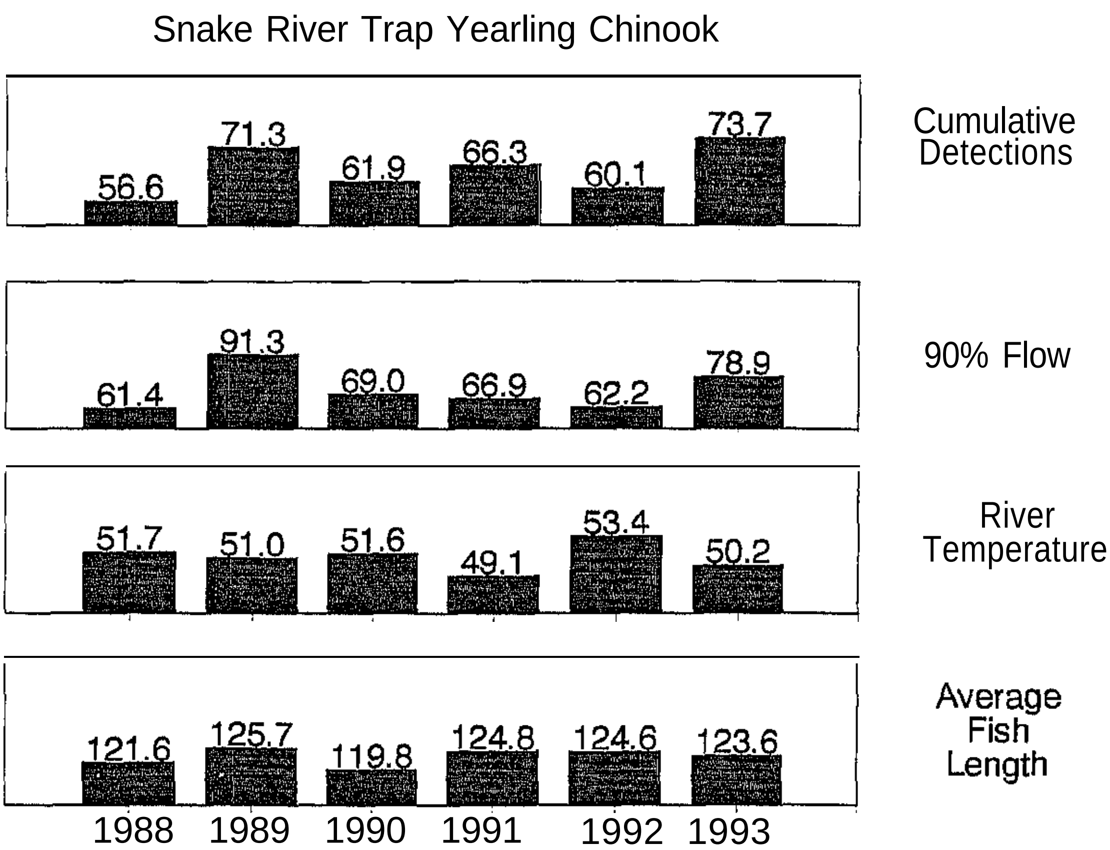


Figure 28. **Annual** statistics averages: (a) cumulative detections; **(b)** flow at time of release **to** 90% detection at LGR; **(c)** river temperature at release to **median** date; **(d)** length of release groups.

The use of cumulative detection rates to represent survival is questionable, however, these data do allow for an analysis of trends in the data. An analysis of variance performed on the data yielded a significant difference in cumulative detections among years. The cumulative detections for 1988, 1992 and 1990 were different than those for 1989 and 1993. The average values for the variables in a given year were examined and compared to the average cumulative detections for the different years (Figure 28). It is apparent that the trend is that the lower flow values are associated with the lowest values for cumulative detections, while the highest flow values are associated with the highest cumulative detections.

Steelhead. The six years of PIT tag releases of steelhead from the Snake River trap generally were made from the second week of April through the first week of June. The most notable exception was 1992, when groups of steelhead were marked through the first week of July. A fin clipping program of all hatchery steelhead from the Columbia Basin allowed the separation of steelhead into groups with their origin either at the hatchery (designated ORIGIN = 0) or in the wild (designated ORIGIN = 1). Unlike the chinook data described previously, the steelhead groups were generally released within the same time periods over the years analyzed with the exception of 1992, when steelhead were released into July. A total of 420 release groups were available for analysis, including 252 hatchery groups and 168 wild groups.

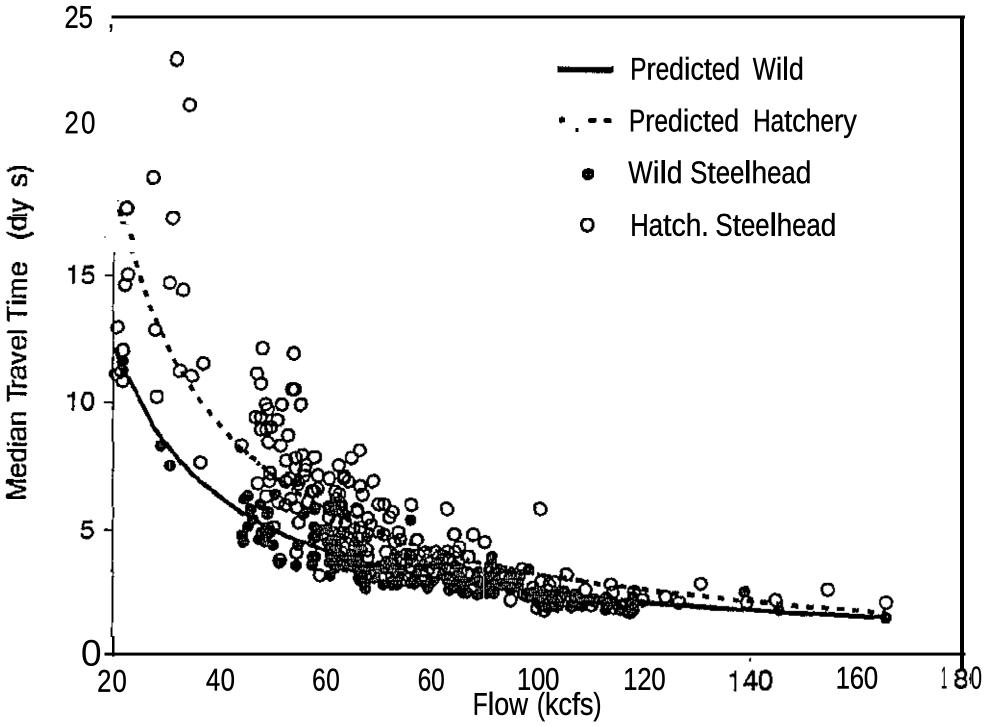


Figure 29. Travel time/flow relations for wild and hatchery steelhead released from the Snake River Trap and recovered at Lower Granite Dam (1988-1993.

Steelhead travel time from the Snake River Trap to Lower Granite Dam was adequately modelled ($R^2=0.677$) with the reciprocal of flow alone (Table 30, Model 1) (Figure 29). An analysis of covariance indicated a significant interaction due to the ORIGIN of the release groups (P=O.OO), but not for the individual YEAR ($P=0.075$). The significant interaction between FLOW-' and ORIGIN persisted even when the analysis was conducted with a subset representing the middle 80% of the steelhead migration. This subset was developed to determine if the late migrating hatchery chinook in 1992 were unduly affecting the analysis.

Hatchery steelhead are generally larger than their wild counterparts as captured by the LENGTH (average length of the release group) variable. The correlation between the LENGTH and ORIGIN for the six years of data was -0.888. The addition of the ORIGIN variable, or substituting the LENGTH variable, improved the overall predictive capability of the model (Table 30, Model 2 and Model 3, R^2 = 0.727 or 0.728, respectively). The average length of the release groups of hatchery steelhead over the six years was 216 mm, while the wild steelhead averaged 176 mm.

The significant interaction between FLOW-' and ORIGIN suggested that the wild and hatchery groups be analyzed separately. When individual years were considered in an analysis of covariance, the yearly slopes were homogeneous ($P=0.278$) for wild chinook ($n=168$), but not for hatchery chinook ($P=0.005$, $n=252$). The simple bivariate model between travel time and the FLOW" variable yielded an $R^2=0.828$

Table 30. Travel time models for PIT tagged **steelhead** released from Snake River Trap, 1988-93.

Model	Variable	Coeff	SE	Prob	MSE	R^2
1	Constant	-0.833	0.204	0.000	2.855	0.677
n=420	FLOW^{-1}	364.922	12.319	0.000		
2	Constant	0.150	0.203	0.460	2.422	0.727
n=420	FLOW^{-1}	355.613	11.397	0.000		
	ORIGIN	-1.355	0.156	0.000		
3	Constant	-6.645	0.688	0.000	2.415	0.728
n=420	FLOW^{-1}	333.430	11.884	0.000		
	LENGTH	0.031	0.004	0.000		

(Table 31, Model 1). The addition of any other variables did not improve this model's predictive capability (Figure 30).

The bivariate relation between the median travel time and FLOW-' for hatchery steelhead yielded an R^2 of 0.707 (Table 31, Model 2). This is typically what is observed when hatchery and wild steelhead are compared annually. Wild steelhead are smaller than hatchery fish and travel at a faster rate than do hatchery steelhead. The wild steelhead relation is usually characterized as having a higher R^2 and lower mean square error around the residuals. In general, wild steelhead are more smolted than their hatchery counterparts. therefore, they respond more directly to flow.

Table 31. Travel time models for wild and hatchery **steelhead** released from the Snake **River** Trap 1988-1993.

Model	Variable	Coeff	SE	Prob	MSE	R^2
WILD STEELHEAD						
1	Constant	0.036	0.133	0.785	0.315	0.828
n=168	FLOW^{-1}	248.129	8.770	0.000		
HATCHERY STEELHEAD						
	Constant	-0,622	0.273	0.023	3.589	0.707
n=252	FLOW”	385.823	15.703	0.000		
3	Constant	-0.209	0.289	0.469	3.416	0.722
n=252	FLOW-'	340.517	19.606	0.000		
	YRCODE92	1.327	0.386	0.000		

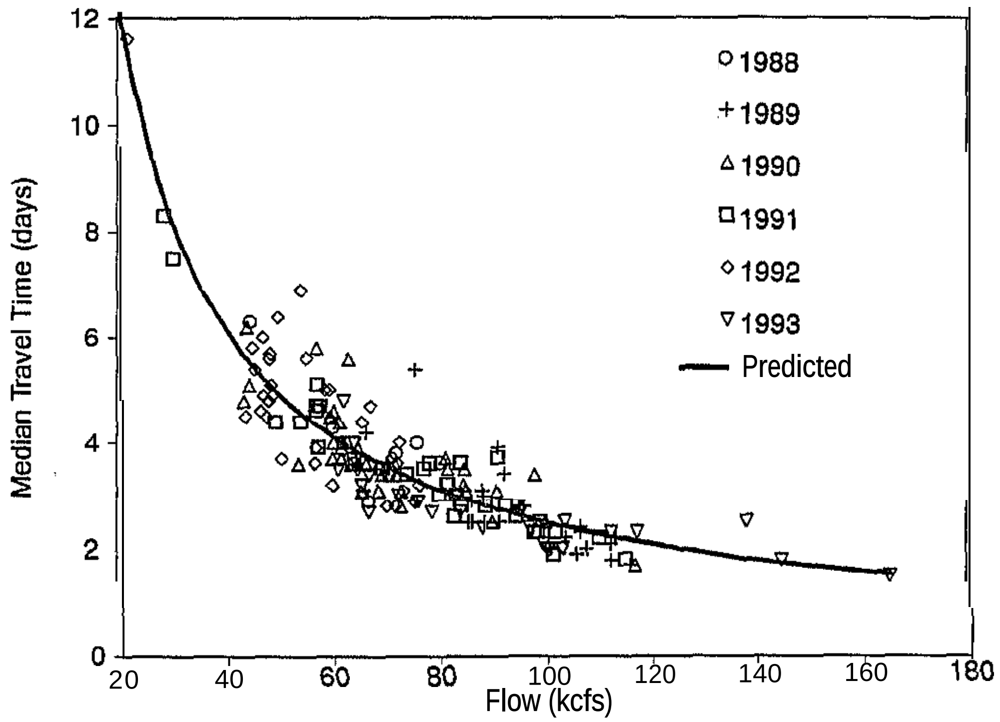


Figure 30. Snake River Trap **wild steelhead travel** time to **Lower Granite Dam** for 1988-1993.

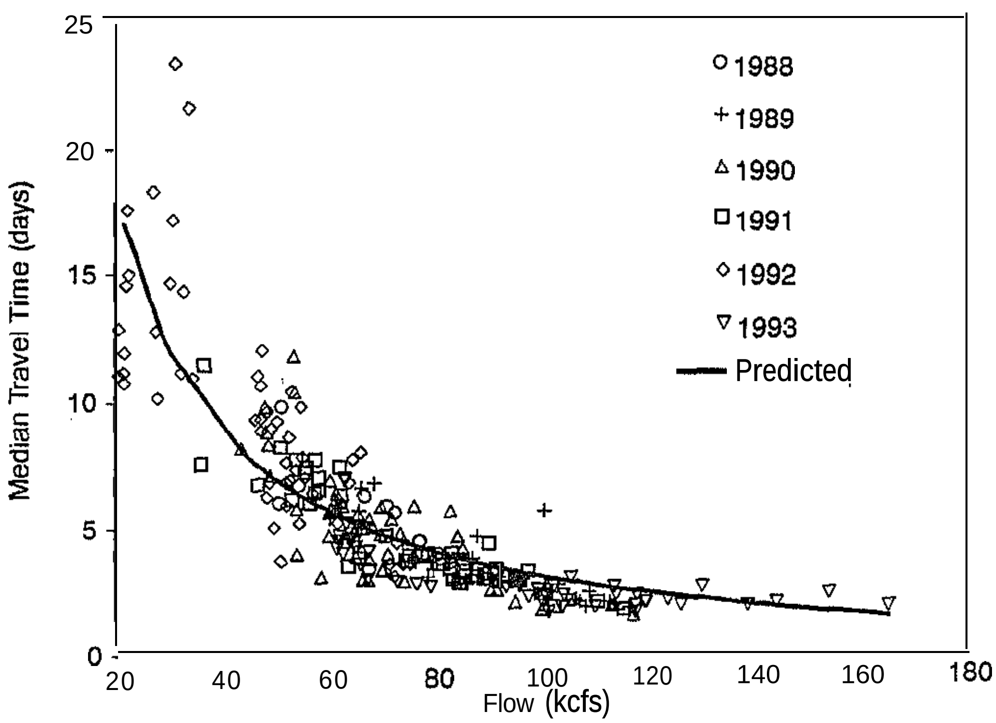


Figure 31. Snake River trap hatchery **steelhead** travel time to Lower Granite Dam, 1988-1993.

The difference in slopes among years for hatchery steelhead was further investigated. The Tukey HSD multiple comparison test was applied to the mean travel time estimates for all six years. The test showed that 1992 was significantly different from all other years. In 1992, a year characterized by extremely low flows, steelhead were marked and released at the trap through the first week of July. The flows associated with the 17 groups that were tagged after June 1 ranged from 20 to 34 kcfs (7 release groups released in flows between 20-25 kcfs, 3 released in flows from 25 to 29 kcfs and 5 released in flows between 30 and 35 kcfs). These groups migrated under very low flows and had correspondingly longer travel time estimates (10 to 24 days) than are typically observed for steelhead (Figure 31). The model for hatchery steelhead could be improved ($R^2=0.722$, Table 31, Model 3) by adding a dummy variable YRCODE92 (equals 1 for 1992, 0 for every other year). None of the other variables tested were as significant as flow when modeled with travel time, or contributed to the significance of the model when incorporated.

b. Little Goose Dam to McNary Dam

A total of 2,452 hatchery chinook, 2,047 hatchery steelhead and 1,066 wild steelhead were PIT tagged and released from Little Goose Dam as part of the Smolt Monitoring Program between April 26 and May 28, 1993. High spill levels occurred at McNary Dam during most of the time period when fish were migrating limiting the number of PIT tagged fish detected. In addition, fish were removed at Lower Monumental Dam and transported from the system. Under some circumstances the transportation program would have diminished the numbers of fish that were recovered at McNary Dam, precluding the development of accurate travel time estimates. However, adequate numbers of fish were recovered at McNary Dam in 1993 because of the high spill levels that occurred at Lower Monumental Dam, minimizing the impact of transportation removals on recovery of fish downstream. With the 1993 recoveries, a significant relation between travel time and reciprocal of flow was obtained for yearling chinook (Table 32 and Figure 32a).

This is the second year of PIT tagging fish at Little Goose Dam as part of the SMP. In 1992 fish travelled under dismal flow conditions. In 1992 the median flows in the mainstem ranged between 47 and 75 kcfs, while in 1993 median flows ranged from 78 to 176 over the same time period. This extreme difference in flow is directly reflected in the travel time estimates. In 1992 the fastest travel time estimate for chinook was 6.1 days, while the longest was 11.8 days with an average of 8.6 days. In 1993 the estimate ranged from 4.1 to 9.5 days with an average of 6.2 days, which is a 28% reduction in average travel time. A statistically significant difference was obtained between the travel time estimates generated by the two years, with travel times being shorter in 1993. A direct comparison of recovery proportions is not possible between the two years since fish were removed at Lower Monumental Dam for transportation in 1993, while in 1992 there was no removal and is reflected in the higher percent detected for that year.

The 1993 travel time estimates for steelhead were considerably shorter than those observed for 1992. The longest travel time estimate in 1993 for hatchery steelhead was 8 days and 7.3 days for wild steelhead, compared to 21.9 days for hatchery steelhead in 1992. The shortest estimates, coincident with the highest flows, were 3.3 days for wild steelhead and 3.7 days for hatchery steelhead, compared to 6.1 days for wild steelhead in 1992. No significant difference in travel time was observed between hatchery and wild steelhead migrants in 1993. A significant relation between steelhead travel time and reciprocal of flow was observed for 1993 (Table 32 and Figure 32b).

Table 32. Travel time models for **yearling chinook** and **steelhead** in the Little Goose Dam to **McNary** Dam index reach, 1993.

Species	Variable	Coeff	SE	Prob	MSE	R^2
Chinook	Constant	2.400	0.734	0.003	0.764	0.575
n=27	FLOW-’	451.245	82.777	0.000		
Steelhead	Constant	1.378	0.620	0.035	0.546	0.626
n=27	FLOW’	439.503	67.949	0.000		

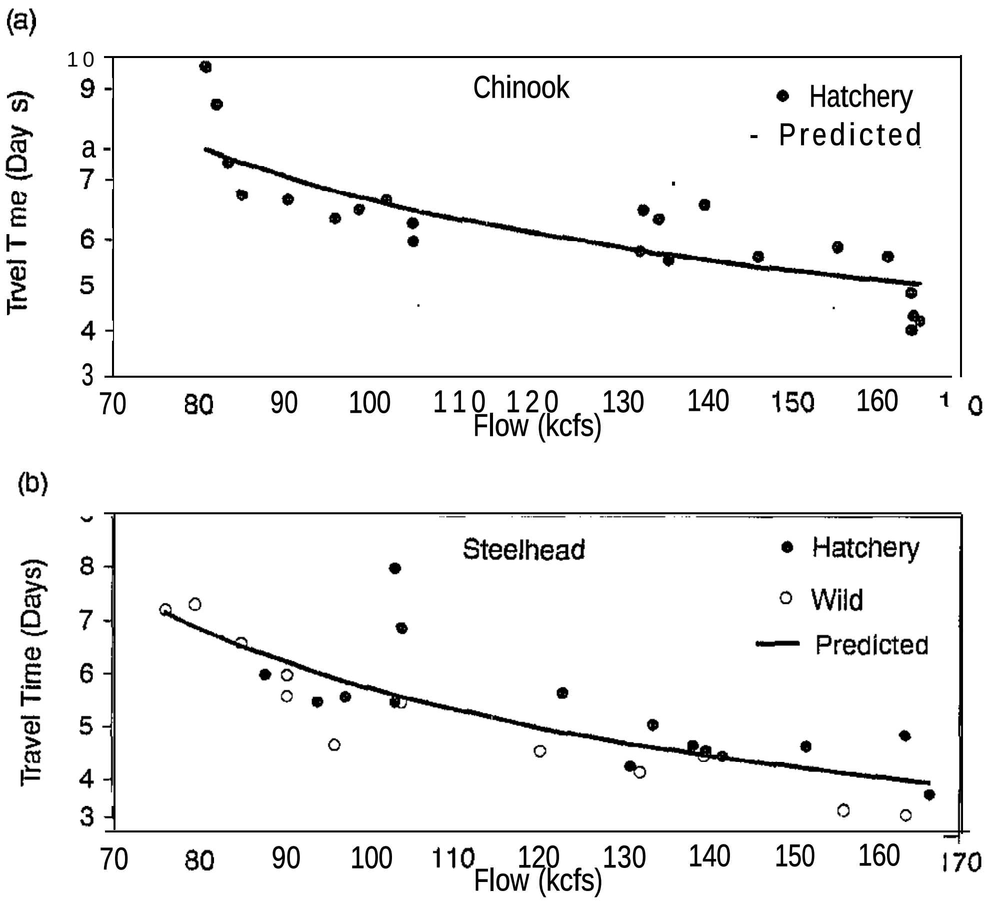


Figure 32. **Travel time/flow** relations for yearling **chinook** (a) and **steelhead (b)** between Little Goose Dam and **McNary Dam in 1993.**

c. Mid-Columbia River - Rock Island to McNary dams.

In 1993, a total of 13,121 salmonids were PIT tagged at Rock Island Dam by Chelan County Public Utility District (PUD) for the SMP. The breakdown was 2,890 yearling chinook, 4,220 subyearling chinook, 1494 hatchery steelhead, 818 wild steelhead, and 3,699 sockeye PIT tagged and released from this dam. The release of PIT tagged smolts began April 20 for sockeye, April 23 for steelhead, and April 26 for yearling chinook. Tagging and release continued daily through May 29 for each species except steelhead, which had no releases for eight days between April 25 and May 2 due to low numbers being caught. Subyearling chinook were PIT tagged and released five days per week (Monday to Friday) for eight weeks starting June 21 and ending August 13. The numbers of smolts detected at McNary Dam over the 1993 migration season from the Rock Island Dam releases were 468 yearling chinook (16.2%), 248 subyearling chinook (5.9%). 126 hatchery steelhead (8.4%), 99 wild steelhead (12.1%). and 536 sockeye (14.5 %). These detection numbers represent only those smolts actually deflected by the screens (STS's) and diverted through the bypass/collection system at McNary Dam: additional PIT tagged smolts passed McNary Dam through the turbines and spillbays undetected. The high levels of spill (≥40% of daily average flow) during much of the 1993 spring migration passed many smolts undetected at McNary Dam this year. For example, steelhead and sockeye smolts had their lowest McNary Dam detection rates, 4-5 % and 7.5 %, respectively, occur during the week of peak spill (averaging 56.7% spill). These detection rates are one-half to one-third the level observed during adjacent dates when more moderate levels of spill (< 40%) occurred at McNary Dam.

The chinook, steelhead, and sockeye travel time data for the Rock Island Dam to McNary Dam. index reach for 1993 and available prior years was analyzed for relations with flow and smoltification related factors. The resulting regression models are presented for each species in the following paragraphs.

Yearling Chinook. Yearling chinook have been PIT tagged and released from Rock Island Dam for five years from 1989 to 1993. In those years, PIT tag releases began between April 19 and 27, and continued for about a 30-day period (a period encompassing the middle 80% of the run). When the East Bank Hatchery's satellite facilities became operational and began releasing yearling summer chinook in 1991, the migration period for yearling chinook at Rock Island Dam became longer. In 1992 and 1993, the period of marking yearling chinook was extended to the end of May to include the yearling summer chinook also. However, it became apparent that the abrupt 2-3 fold increase in daily median travel time estimates for late May must be due to some behavioral differences between the earlier migrating spring races and later migrating summer races. Because of this potential difference between races, only releases through May 17 and May 20 in 1992 and 1993. respectively, were used in the analyses with the previous three years. In addition, yearling chinook groups released before April 26 in 1989 to 1992 were excluded from the five-year analysis because no data for that time period was available for 1993. This was due in part to a delay in permits to release hatchery production in 1993. In the prior years. these early releases had produced some very long median travel time estimates. The exclusion of early and late migranrs provided a total of 86 release groups covering a similar time period each year for analysis. These release groups consisted of single-day and multi-day blocks of releases. High spill levels at McNary Dam in 1991 and 1993 helped divert more fish away from the powerhouse and reduced the numbers of PIT tagged fish detected in the bypass at McNary Dam. Therefore, more multi-day blocks were required in those two years.

Three potential models emerged in the analysis for yearling chinook -- one with serial date alone, one with reciprocal of flow alone, and the other with temperature and reciprocal of flow together. The correlation between natural log of travel time (LNTT) and release date (SERIAL), temperature (TEMP) and reciprocal of flow (FLOW-‘) was -0.71, -0.48, and 0.52, respectively, for the five years of data combined. SERIAL was the single variable with the most predictive capability as measured by R^2 value, explaining 51% of the variation in natural log of travel time (Table 33, Model 1). Predictive capability dropped to an R^2 of 43 % for the model containing TEMP and FLOW-’ jointly (Table 33, Model 2). The model with FLOW’ alone had an R^2 of 27% (Table 33, Model 3). When individual years were considered in an analysis of covariance, the yearly slopes were homogeneous for the single variable models with either SERIAL ($P=0.08$) or FLOW’ ($P=0.25$), but had significant interactions among yearly slopes ($P < 0.01$) for the two-variable model with TEMP&FLOW^{-1}. When individual years were compared in this latter model, there was generally strong correlations (ranging from $r=-0.35$ to $r=0.98$) between the two predictor variables. The slope of the FLOW’ variable was significant in only three years. while that of the TEMP variable was significant in only two years. The lack of correlation between TEMP and FLOW’ ($r=0.16$, $n=86$) in the combined years’ model was a spurious result, and so this model was dropped from further consideration, The model containing the SERIAL variable had a significant difference in intercepts among years ($P<0.01$). The Tukey HSD multiple comparison test was applied to the adjusted mean travel time estimates (adjusted to mean serial date of all five years). The test showed two significantly different groups of years -- 1989. 1990, and 1992 versus 1991, 1992, and 1993 (overlap with 1992). The adjusted mean travel times were 11 days for 1989 and 1990, 12 days for 1992. and 13 days for 1991 and 1993. The model containing the FLOW’ variable also had a significant difference in intercepts among years ($P=0.002$). The Tukey HSD multiple comparison test was applied to the adjusted mean travel time estimates (adjusted to mean flow of all five years). The test showed two significantly different groups of years -- 1989. 1990, 1992, and 1993 versus 1991 and 1993 (overlap with 1993). The adjusted mean travel times were 11 days for 1989. 1990, and 1992, 12 days for 1993. and 13 days for 1991.

In comparing the models containing either the SERIAL or FLOW’ variables for yearling chinook. it is apparent that 1991 is characterized as having higher flows and cooler water temperatures than the other four years over most of the yearling chinook migration period (Figures 33 and 34). In 1993 the

Table 33. Travel time models for PIT tagged yearling chinook released from Rock Island Dam, 1989-93.

Model	Variable	Coeff	SE	Prob	MSE	R^2
1	Constant	3.5808	0.1273	0.000	0.0147	0.507
n=86	SERIAL	-0.0173	0.0019	0.000		
2	Constant	3.8912	0.4531	0.000	0.0172	0.430
n=86	TEMP	-0.0399	0.0084	0.000		
	$FLOW^{-1}$	83.5004	15.3221	0.000		
3	Constant	1.7829	0.1117	0.000	0.0216	0.274
n=86	$FLOW^{-1}$	95.4577	16.9593	0.000		
4	Constant	4.1234	0.5080	0.000	0.0147	0.514
n=86	TEMP501	-0.0109	0.0099	0.273		
	SERIAL	-0.0175	0.0019	0.000		
5	Constant	3.3684	0.5719	0.000	0.0200	0.337
n=86	TEMP501	-0.0362	0.0128	0.006		
	$FLOW^{-1}$	119.0884	18.3215	0.000		

water temperatures closely followed the levels observed in 1991, but the flows ranged from the lowest of the five years before May 10 to the second highest flows after May 15. River temperatures in 1992 were the highest of the five years, averaging around 4°F higher than 1991 and 1993 over most of the yearling chinook migration period. Flows in 1992 averaged lower over the yearling chinook migration season than the other four years, although the 1992 flows were higher than other years during various segments of the season. The lower river temperatures for 1991 and 1993 appeared to be a common link between those two years and their similar travel time response. The river temperature on May 1 (TEMP501) in each year was used to represent the year effect in the two regression models. For the model with the SERIAL variable, the TEMP501 variable was not significant ($P=0.273$; Table 33, Model 4), but it was significant in the model with the FLOW' variable ($P=0.006$; Table 33, Model 5), and increased the overall model R^2 value to 34 %. The sign of the TEMP501 variable was negative, indicating a longer travel time at cooler water temperatures for a fixed level of flow. Since the two years with higher flows also had the lower river temperatures, there did exist a significant correlation between the two predictor variables TEMP501 and FLOW-' ($r=0.46$, $P<0.01$). Figure 35 shows the predicted travel time curves given a May 1 river temperature of 46°F and 49°F. The lower temperature curve corresponds closest to the 1991 and 1993 observations, and the higher temperature curve to the other three years. The effect of increased river temperature was about a 1 to 1½ day decrease in median travel time for a given level of flow. Increases in flow from 120 to 200 kcfs is predicted to decrease median travel time about 4 days. A similar 4-day decrease in median travel time is predicted from the model

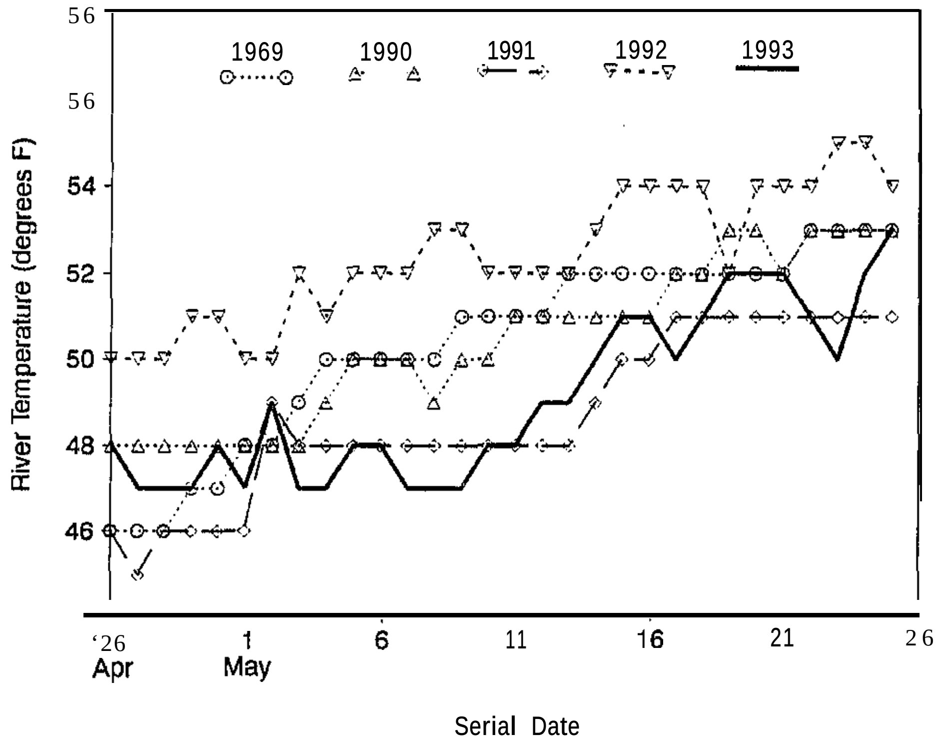


Figure 33. **Spring** water temperature at Priest Rapids Dam, **1989-1993.**

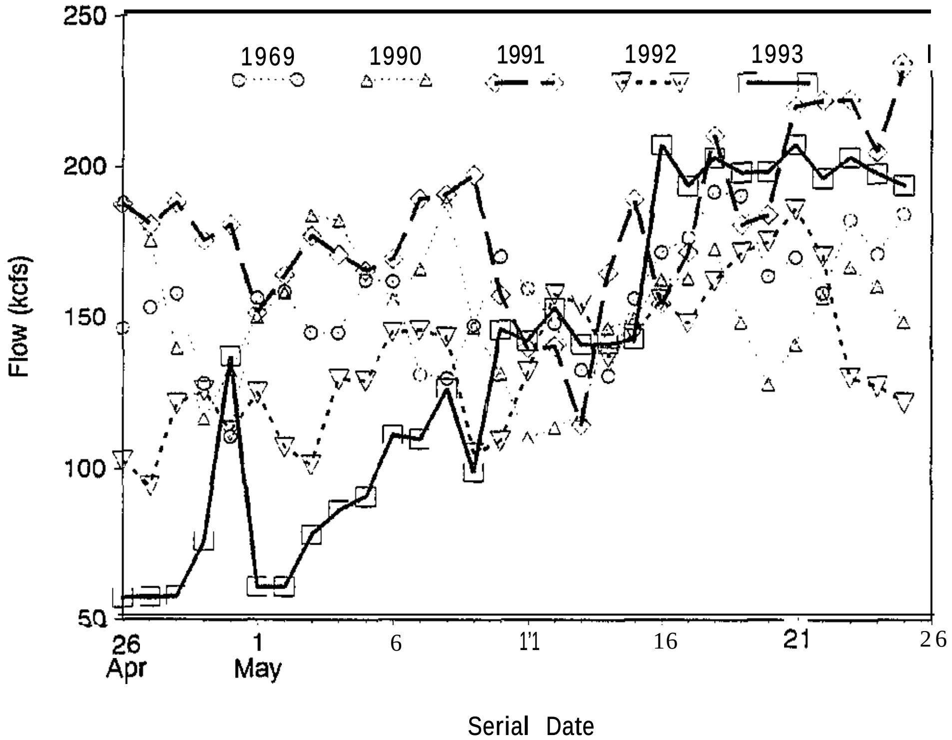


Figure 34. Spring **flows at Priest** Rapids Dam, **1989-** 1993.

containing the SERIAL variable for yearling chinook released 14 days later than an earlier released group (Figure 28).

Since river temperature increases over time, and flow usually increases over time during the yearling chinook migration season (1990 was an exception), it is difficult to separate the individual contribution of these factors to the resulting median travel time of yearling chinook. Since smoltiftcation increases over time at a rate that is affected by water temperature (Hoar 1988). it is apparent that smoltification plays an important role in the migration rate of the mid-Columbia River yearling chinook run. Under the range of flows observed during the 5 years of study, it appears that the flow effect may have been secondary to the smoltification effect in regards to yearling chinook travel time. Berggren and Filardo (1993) reported on the predominance of a smoltification influence on the travel time of mid-Columbia spring chinook from Winthrop Hatchery under a limited flow range from 1983 to 1990.

Steelhead. Steelhead have also been PIT tagged and released from Rock Island Dam during the five years from 1989 to 1993. In those years, PIT tag releases began between April 19 and 28, and continued for about a 30-day period (a period encompassing the middle 80% of the run). The analysis for steelhead used a total of 140 release groups (58 wild and 82 hatchery groups) from the entire marking period in those five years. As with yearling chinook, more multi-day blocks were required in 1991 and 1993 during periods of high spill.

Steelhead travel time in the mid-Columbia River reach was adequately modelled with the reciprocal of flow alone. The correlation between natural log of travel time (LNTT) and release date (SERIAL), temperature (TEMP) and reciprocal of flow ($FLOW^{-1}$) was -0.36, -0.26, and 0.74, respectively, for the five years of data combined. $FLOW^{-1}$ was the single variable with the most predictive capability as measured by R^2 value, explaining 55% of the variation in natural log of travel time (Table 34, Model I). Predictive capability dropped to an R^2 of 13 % and 7% for single variable models containing SERIAL and TEMP, respectively. Although a joint model with $FLOW^{-1}$ and TEMP would increase the overall R^2 value, it would be an inappropriate model for the same reasons as previously discussed for yearling chinook. Therefore, analyses concentrated on a model with the $FLOW^{-1}$ variable, and the effects of rearing type (ORIGIN variable: "1" = wild and "0" = hatchery) and year. When individual years and rearing types were considered in an analysis of covariance, the yearly slopes were homogeneous ($P=0.13$) as were the rearing type slopes ($P=0.12$). There was a significant difference ($p<0.01$) between rearing types and again between years in the model. The Tukey HSD multiple comparison test was applied to the adjusted mean travel time estimates (adjusted to mean flow of all five years). The test showed two significantly different groups of years -- 1989, 1990, 1991 and 1993 versus 1992 (no overlapping years). The adjusted mean travel times for year effects were 10 days for 1992 and 8 days for the other four years. The adjusted mean travel times for rearing type effects were 7.7 days for wild steelhead and 8.7 days for hatchery steelhead.

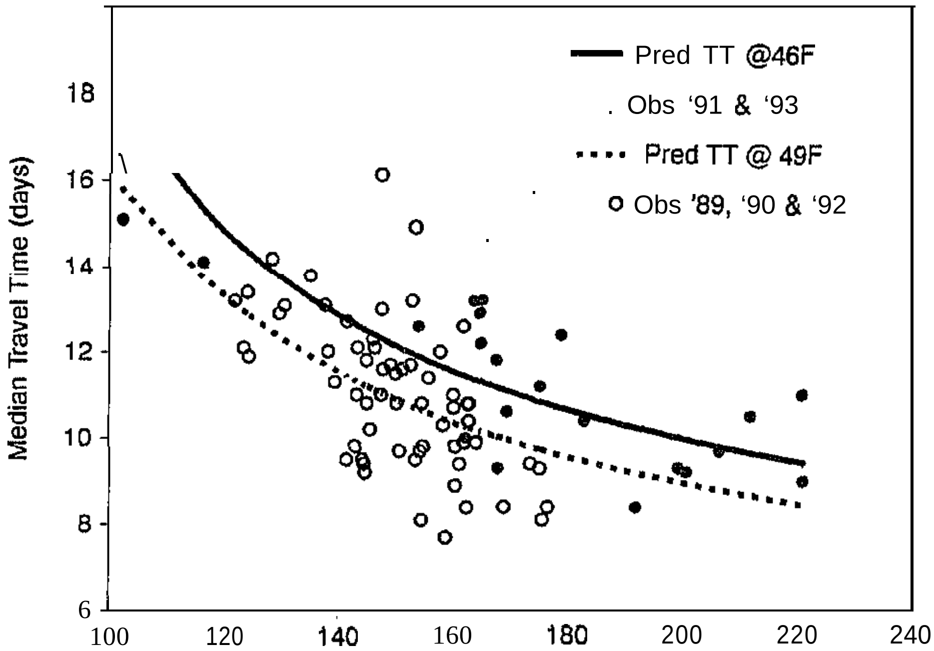


Figure 35. Yearling chinook travel time from Rock Island Dam to McNary Dam related to flow at fixed water temperatures.

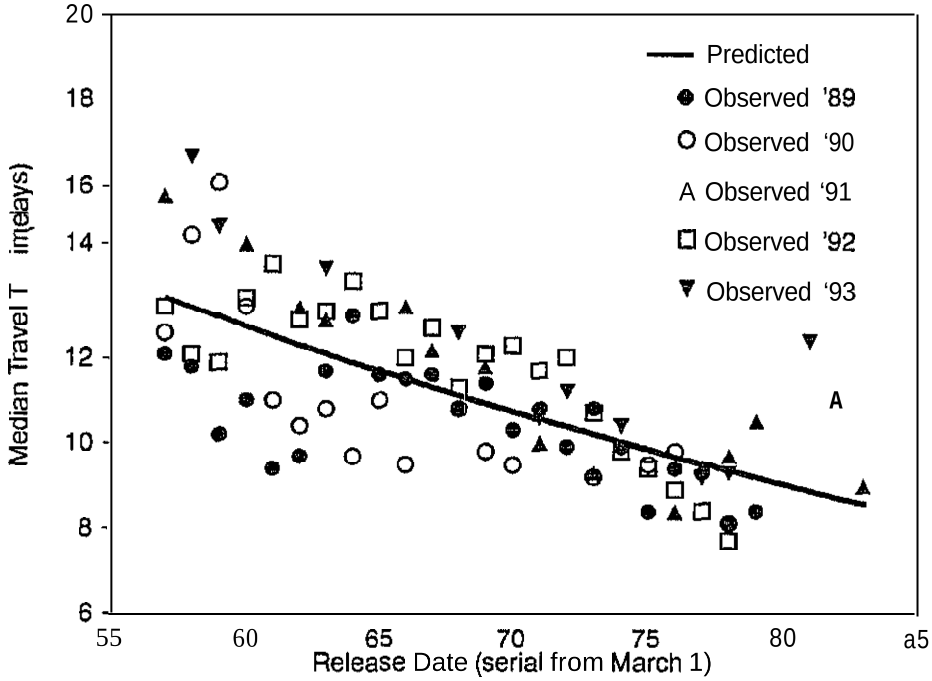


Figure 36. Yearling chinook travel time from Rack Island Dam to McNary Dam related to date of release.

Table 34. Travel time models for PIT tagged **steelhead** released from Rock **Island** Dam, 1989-93.

Model	Variable	Coeff	SE	Prob	MSE	R^2
1	Constant	0.9606	0.0933	0.000	0.0271	0.548
n=140	$FLOW^{-1}$	179.4811	13.8856	0.000		
2	Constant	-1.7761	0.4158	0.000	0.0181	0.702
n=140	ORIGIN	-0.1171	0.0231	0.000		
	TEMP501	0.0648	0.0095	0.000		
	$FLOW^{-1}$	127.2153	13.6572	0.000		
3	Constant	1.0105	0.0887	0.000	0.0241	0.601
n=140	ORIGIN	-0.1138	0.0266	0.000		
	$FLOW^{-1}$	179.0737	13.0929	0.000		

The consistent difference between 1992 and the other four years was the higher river temperatures that year during the steelhead migration period (Figure 33). Also flows in 1992 averaged lower over the steelhead migration season than the other four years, although the 1992 flows were higher than other years during various segments of the season. As was the case with yearling chinook, the river temperature on May 1 (TEMP501) in each year was used to represent the year effect in the regression model. The TEMP501 and ORIGIN variables were significant ($P<0.01$) contributors to the model with the FLOW' variable, and increased the overall model R^2 value to 70% (Table 34, Model 2). There was a significant correlation between the FLOW-' and TEMP501 variables ($r=0.56$, $P<0.01$). This correlation, coupled with the fact that the majority of the 1992 observations occurred at the lower range of flows (below 140 kcfs) in the S-year period, makes it uncertain as to the extent of the river temperature effect. The positive sign of the TEMP501 variable implies that the higher temperatures in 1992 tended to increase the travel time of steelhead smolts at a given level of flow compared to the other years. This sign is opposite of what was obtained in the yearling chinook model. Since the higher river temperatures observed in 1992 remained below 55°F during the steelhead migration period, well within the optimum temperature range for steelhead (Bell 1991), it is unlikely the 2-4°F higher temperatures in 1992 compared to the other four years would have increased travel times. on average, one to two days higher at a fixed level of flow. Therefore. the more parsimonious 2-variable model with ORIGIN and $FLOW^{-1}$ (Table 34. Model 3) is the preferred model (Figure 37). This model had an R^2 of 60%.

Sockeye Salmon. Sockeye have been PIT tagged and released from Rock Island Dam for two years from 1992 to 1993. PIT tag releases were made between April 18 and May 31. Almost three times more sockeye were PIT tagged in 1993 than in 1992 (3,699 sockeye versus 1,297 sockeye). Only 2% of the sockeye PIT tagged in 1993 were of hatchery origin compared to 35% hatchery sockeye in 1992. These hatchery sockeye were East Bank Hatchery fish that were reared in Lake Wenatchee. The hatchery and

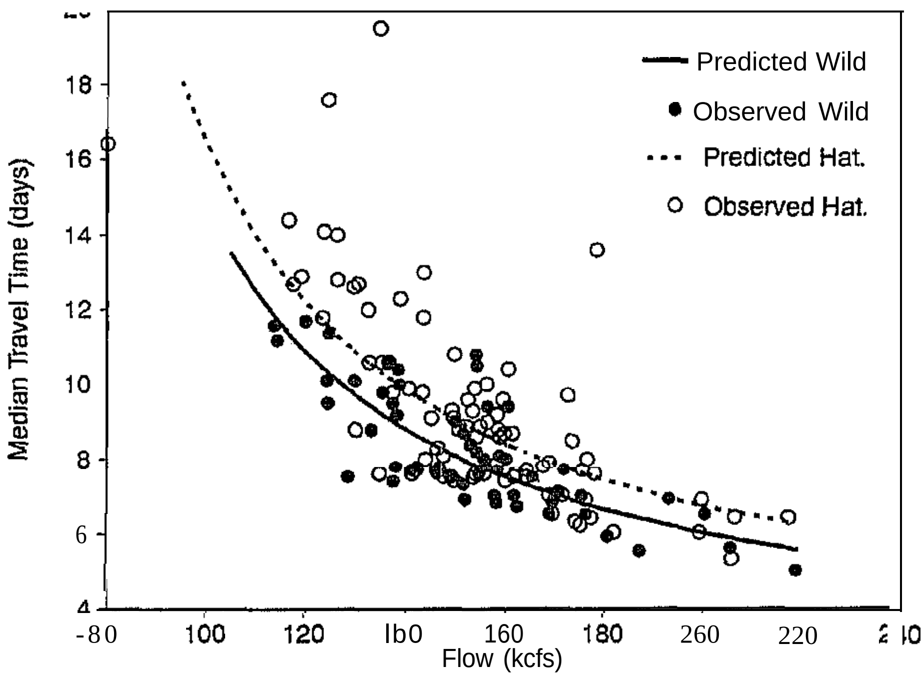


Figure 37. Wild and hatchery steelhead travel time from Rock Island Dam to McNary Dam related to flow.

wild sockeye were combined in analyses as no significant difference in median travel time was detected between rearing types with the 1992 data either when adjusted for the FLOW-' variable ($P=0.48$, $n=22$) or adjusted for the SERIAL variable ($P=0.70$, $n=22$) in an analysis of covariance. The wild sockeye run passing Rock Island Dam consists of two stocks, originating from Lake Wenatchee and Lake Osoyoos, which are fairly well separated temporally. Historically, May 5 has been used as a cut-off date between the two stocks (Peven 1991). The Osoyoos stock run size has been lower than that of the Wenatchee in recent years. In 1992, the sockeye run-at-large had peak passage before May 5, but 1993 has seen a reversal in passage timing. A bimodal passage pattern occurred in 1993, but with most passage occurring after May 5, peaking after mid-May (Appendix C, Figure 7). This change in passage timing may reflect increased contribution of Osoyoos stock sockeye in the 1993 run, and a delay in outmigration timing of Wenatchee stock sockeye due to cooler water temperatures in 1993. The May 1 river temperatures were 3°F cooler in 1993 than in 1992 at Rock Island Dam. The mixed stock run was simply analyzed as sockeye The analysis covered the entire period when sockeye were PIT tagged and released during these two years.

Three potential models emerged in the analysis for sockeye -- one with serial date alone, one with reciprocal of flow alone, and the other with serial date and flow applied to different segments of the run. The correlation between natural log of travel time (LNTT) and release date (SERIAL), temperature

(TEMP) and reciprocal of flow (FLOW-') was -0.76, -0.46, and 0.72. respectively, for the two years of data combined. SERIAL was the single variable with the most predictive capability as measured by R^2 value, explaining 57% of the variation in natural log of travel time (Table 35. Model 1). Predictive capability was nearly the same with FLOW' alone with an R^2 of 52% (Table 35, Model 2). When individual years were considered in an analysis of covariance, the yearly slopes and intercepts were homogeneous ($P=0.39$ and $P=0.75$, respectively) for the model with the SERIAL variable, but the yearly slopes had significant interactions ($P=0.024$) in the model with the FLOW' variable. Figure 38 shows that the model containing the SERIAL variable did not agree closely with observations after day 80 (May 19). After that date, flows were decreasing each year. A model containing the FLOW" variable with different slopes between years but common intercept (Table 35, Model 3. $R^2=67\%$) failed to adequately depict the steepness of the I992 slope, but it did visually show that for flows above 100 kcfs, both years probably follow a similar relation (Figure 39).

To further investigate the year effect, the data was stratified into two periods: one from April 18 to 29 and the other from April 30 to May 31. For the early period, a significant relation was generated with the SERIAL variable ($P<0.01$; $R^2=79\%$; Table 35, Model 5), but not with the FLOW' variable ($P=0.16$; $R^2=13\%$; Table 35, Model 4). The predictive capability of the model containing the SERIAL variable was improved to an R^2 of 89% (Table 35, Model 6) by including a YEARCODE variable (*i.e.*, "0" = 1992 and "1" = 1993) to account for the significant difference in intercepts (with common slope, $P=0.80$) between years ($P=0.004$). The higher median travel time curve for 1993 in Figure 40 is reasonable given the *lower* river temperatures *and* lower flows that occurred *for* marked groups released during this time. For the later period, a significant relation could be generated with either the SERIAL variable or the FLOW-' variable alone ($P<0.01$), but the predictive capability was twice as great with the model containing the FLOW-' variable ($R^2=73\%$; Table 35, Model 8) than with the model containing the SERIAL variable ($R^2=31\%$; Table 35, Model 7). Figure 41 shows the travel time/flow relation generated for releases made after April 30 agrees closely with the observations of both years. In both 1992 and 1993, sockeye travel times between Rock Island and McNary dams were influenced primarily by flows from April 30 to the end of the season and primarily by other factors, such as date and river temperatures. before April 30. Since smoltification has been shown to increase with in-river migration (Zaugg *et* al. 1985). it appears that the later migrating, more smoked. sockeye were the ones responding to flows.

Subyearling chinook. For subyearling chinook released from Rock Island Dam during the summer months. no significant correlation was observed between natural log travel time and either reciprocal of flow ($r=0.22$, $n=11$). river temperature ($r=0.172$, $n=11$), and release date ($r=0.035$, $n=11$). Median travel times ranged from 18.9 to 38.2 days during eight weekly blocks in 1993, and from 30.5 to 35.5 days during three weekly blocks in 1992. The overall average was 29.3 days with a 25-34 day 95%

Table 35. Travel *time models* for PIT **tagged** sockeye released from Rock Island Dam, 199293.

Model	Variable	Coeff	SE	Prob	MSE	R2
1	Constant	3.7508	0.1934	0.000	0.0471	0.574
n=41	SERIAL	-0.0211	0.0029	0.000		
2	Constant	1.5815	0.1270	0.000	0.0533	0.518
n=41	$FLOW^{-1}$	95.8554	14.8026			
3	Constant	1.3691	0.1172	0.000	0.0371	0.673
n=41	FLOW”	138.1823	15.8765	0.000		
	YEARCODE* FLOW’	-33.1538	7.8127	0.000		
		Release period: April 18 to April 29				
4	Constant	2.2695	0.2253	0.000	0.0333	0.126
n=17	$FLOW^{-1}$	31.0580	21.1568	0.163		
5	Constant	4.9798	0.3187	0.000	0.0080	0.790
n=17	SERJAL	6.0439	0.0059	0.000		
6	constant	5.1789	0.2484	0.000	0.0046	0.887
n=17	YEARCODE	0.1198	0.0345	0.004		
	SERIAL	-0.0486	0.0046	0.000		
		Release period: April 30 to May 31				
7	Constant	3.6999	0.4821	0.000	0.0722	0.305
n=24	SERIAL	-0.0203	0.0065	0.005		
8	Constant	0.5266	0.2218	0.027	0.0282	0.729
n=24	FLOW’	253.1491	32.9239	0.000		

confidence interval. The fastest subyearling chinook traversed the Mid-Columbia River reach in one week and the slowest individual took over 3 months.

d. Lower Columbia River - McNary to John Day dams.

In 1993, a total of 61,543 salmonids (49,653 yearling chinook and 11,890 steelhead) were freeze branded at McNary Dam by Washington Department of Fisheries for the SMP. The yearling chinook were released in 1993 over a six-week period between April 19 and May 28, and the steelhead were released over a three-week period between May 3 and May 2 1. In the yearling chinook analyses, large recovery numbers allowed the first two weekly periods to be each split into two 3-day blocks, while the remaining four weekly periods remained as 5-day blocks. This produced 8 blocks for which median travel time was computed for yearling chinook in 1993 (Appendix E, Table XXII). In the steelhead analyses, the first weekly period was split into one 2-day block and another 3-day block; the second

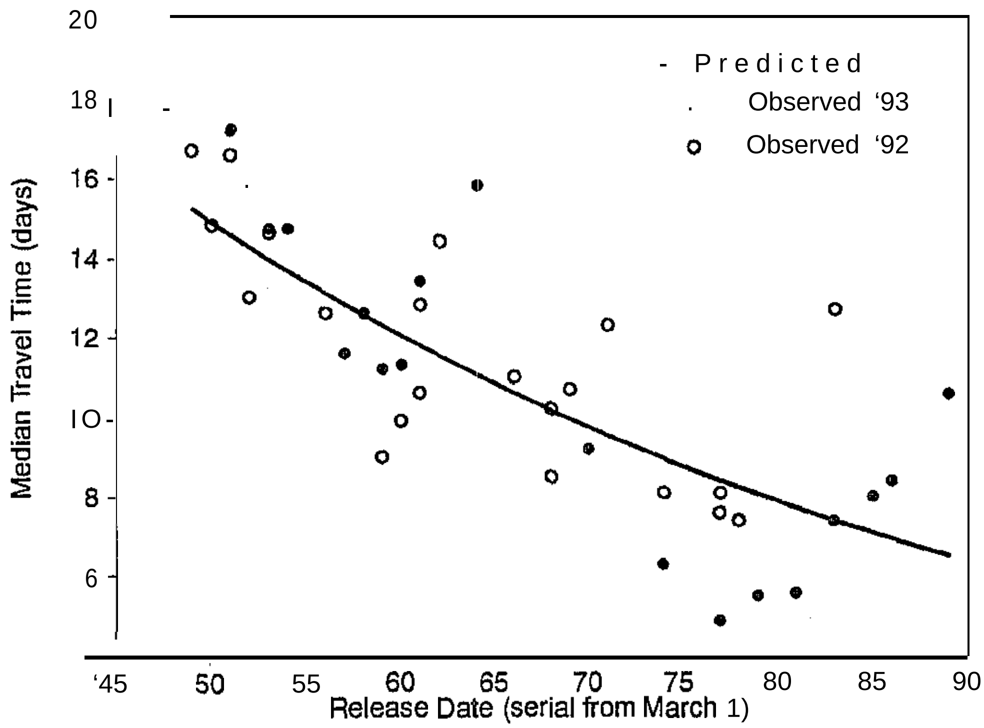


Figure 38. Sockeye travel time from Rock Island Dam to **McNary** Dam related to date of release.

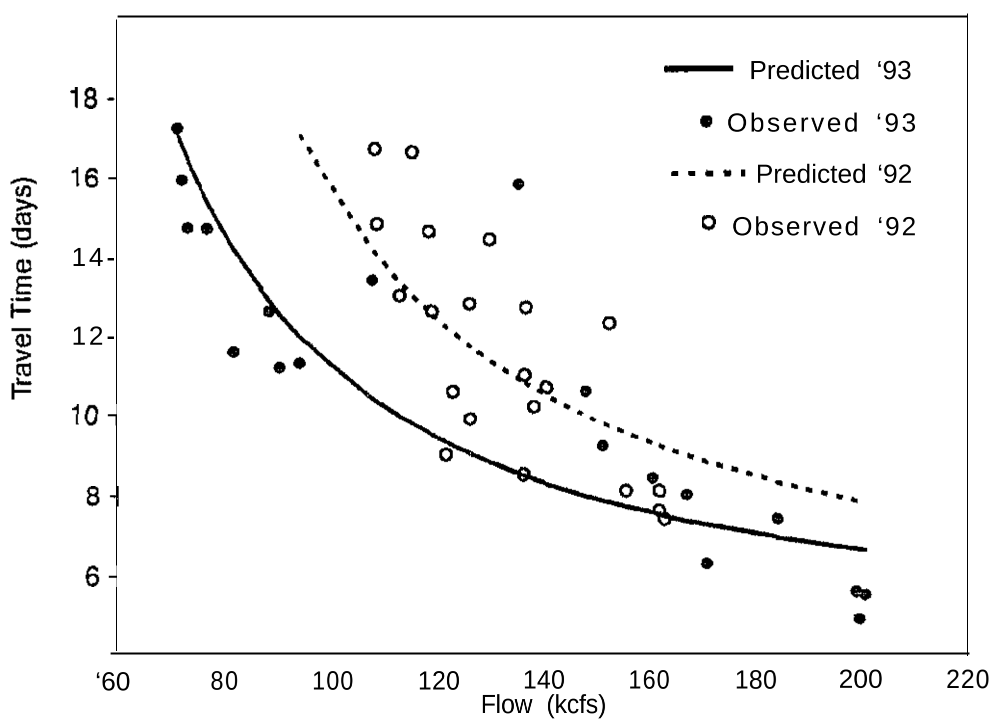


Figure 39. Sockeye travel time from Rock **Island** Dam to **McNary** Dam related to flow.

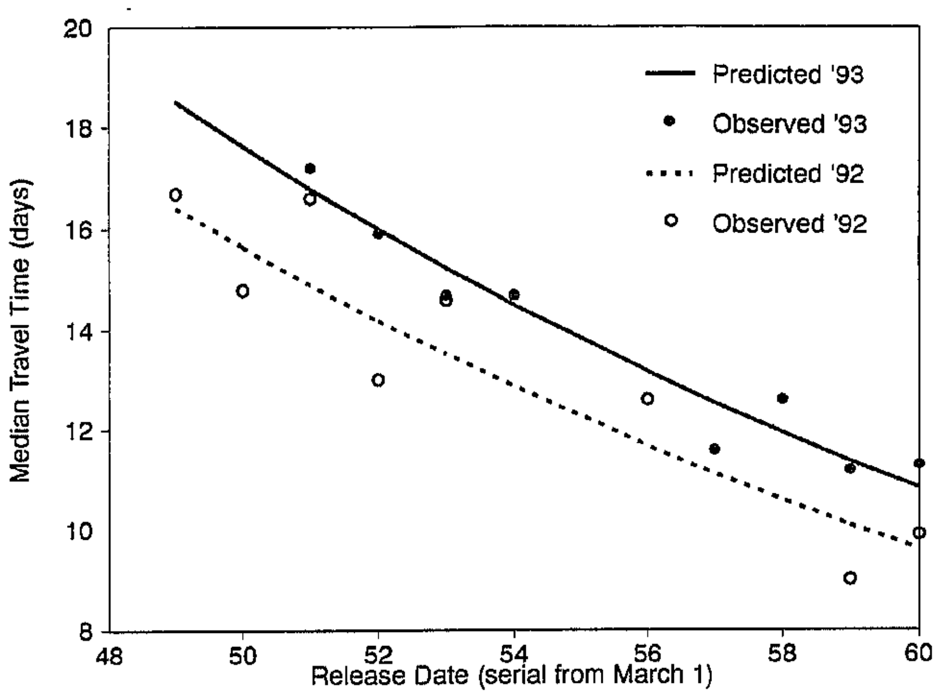


Figure 40. Sockeye travel time from Rock Island Dam to McNary Dam for PIT tag releases between April 18 and 29 related to date of release.

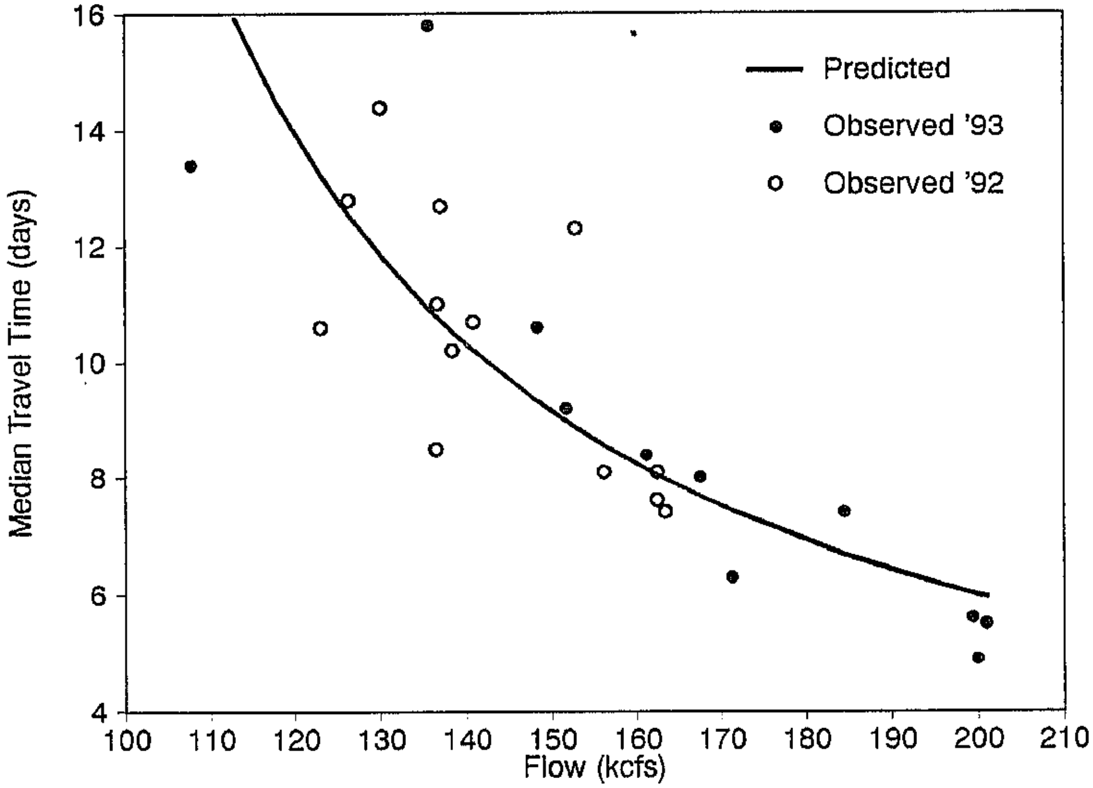


Figure 41. Sockeye travel time from Rock Island Dam to McNary Dam for PIT tag releases between April 30 and May 31 related to flow.

weekly period was reduced to a 4-day block with the May 10 release omitted; and the third weekly period remained as a 5-day block. This produced 4 blocks for which median travel time was computed for steelhead in 1993 (Appendix E, Table XXII). The omission of the May 10 steelhead release was due to (i) no sampling in John Day Dam's Unit 3 during peak passage of this release group, and (ii) the shift from sampling with two airlifts to one airlift at that time. Unit 3 was taken out of service on May 14 so that the airlift samplers could be inspected and repaired to reduce mortality levels in collected smolts. The reduction in sampling effort had negligible impacts on the travel time distributions computed for groups released through May 7 and after May 10. The May 10 release of yearling chinook passed after May 14, while the May 10 release of steelhead appeared to mostly pass on May 14, requiring removal of this group from further analyses.

Yearling Chinook. A regression analysis for yearling chinook was conducted using data from 1993 along with data from the years 1986-88 and 1989-92. From 1989 to 1993, freeze brand codes were changed daily so that the actual travel time (to the nearest day) could be determined for each recovered fish (yearling chinook or steelhead), and a distribution of travel time estimates could be generated for each release block. In 1986 to 1988 a release block consisted of multi-day releases of yearling chinook with the same freeze brand code. The difference between the interpolated median date of release and the interpolated median date of recovery at John Day Dam was used to obtain an initial estimate of travel time for the block. Skalski (1988) documented that the pattern of release ofbranded yearling chinook within a block could bias the median release date computed, and thereby bias the estimate of median travel time for the block. The release date bias values reported by Skalski were added to the initial estimates of median travel time to produce final (more accurate) estimates of median travel time for the blocks. With this adjustment, the final 1986-88 data agreed closely with the results observed in subsequent years.

A significant travel time/flow relation for yearling chinook was generated with the eight years of data (Table 36). The 1993 data fully spanned the range of flows and showed very close agreement to the prediction line based on all eight years (Figure 42). The relation predicts that the time it takes yearling chinook to traverse John Day pool would be 8.2 days at 150 kcfs, 6.1 days at 200 kcfs, 4.7 days at 250 kcfs. and 3.9 days at 300 kcfs.

The predictive model for yearling chinook travel time was increased by adding a smoltification surrogate variable. When the release date (SERIAL) variable was added to the model with reciprocal of flow (FLOW-') variable. the R^2 value increased over 10 percentage points (Table 36). The river temperature (TEMP) variable did not have a simlar effect. Figure 43 shows three prediction curves generated by holding the SERIAL variable fixed at three levels: April 19, May 6, and May 23. For graphical purposes, observations with release dates that are within ± 8 days of a particular DATE level are assigned to that level. This assignment of observations to strata is only to show which data points

Table 36. Travel time models for yearling chinook **and steelhead** in the **McNary** Dam to John Day Dam index reach'.

Model	Variable	Coeff	SE	Prob	MSE	R^2
YEARLING CHINOOK						
1	Constant	-0.498	0.678	0.467	1.026	0.622
n=50	FLOW"	1311.354	147.686	0.000		
2	Constant	8.422	2.149	0.000	0.751	0.729
n=50	FLOW"	984.826	147.323	0.000		
	SERIAL	-0.057	0.013	0.000		
3	Constant	4.990	2.996	0.102	0.975	0.648
n=50	FLOW'	1238.979	149.011	0.000		
	TEMP	-0.096	0.051	0.067		
STEELHEAD						
I	Constant	-1.165	0.953	0.238	0.598	0.626
n=20	FLOW"	1280.989	233.227	0.003		
	Constant	1.906	3.203	0.560	0.598	0.647
n=20	FLOW'	1217.623	241.559	0.000		
	SERIAL	-0.021	0.021	0.329		
3	Constant	-6.120	4.364	0.179	0.587	0.654
n=20	FLOW-'	1311.810	232.490	0.000		
	TEMP	0.089	0.076	0.261		

[1] Based on **McNary** Dam freeze brand releases from 1986-93 for yearling chinook and from 1989-93 for **steelhead.**

have greater influence on a particular curve: it does not indicate the use of a series of separate regression analyses. What this plot demonstrates is that for a constant flow, travel time will decrease as the outmigration season progresses at a rate of one day for every release 17 days apart. At a constant date, travel time will decrease at a rate of one day when flow increases from 150 to 175 kcfs, or from 200 to 250 kcfs, or from 250 to 340 kcfs. The release date variable functioned as a surrogate for smoltification, which increases over time. In this analysis, both flow and smoltification are shown to influence yearling chinook travel time in John Day pool.

Steelhead. The regression analysis for steelhead used data from 1993 along with data from 1989-1992. A significant relation between travel time and flow for steelhead was generated with the five years of data (Table 36). The 1993 data added a couple of points to the higher end of the flow range (Figure 44). The relation predicts that the time it takes steelhead to traverse John Day pool would be 5.2 days at 200 kcfs, 4.0 days at 250 kcfs, 3.1 days at 300 kcfs, and 2.5 days at 350 kcfs. These predictions

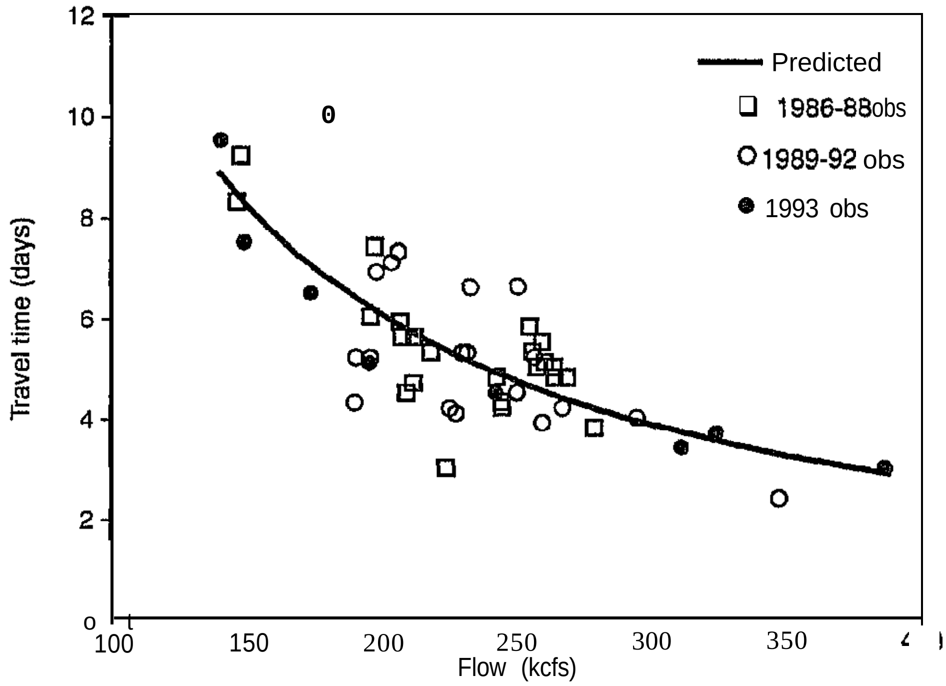


Figure 42. Travel time/flow relation form yearling chinook in the McNary Dam to John Day Dam index reach based cm 198693 data.

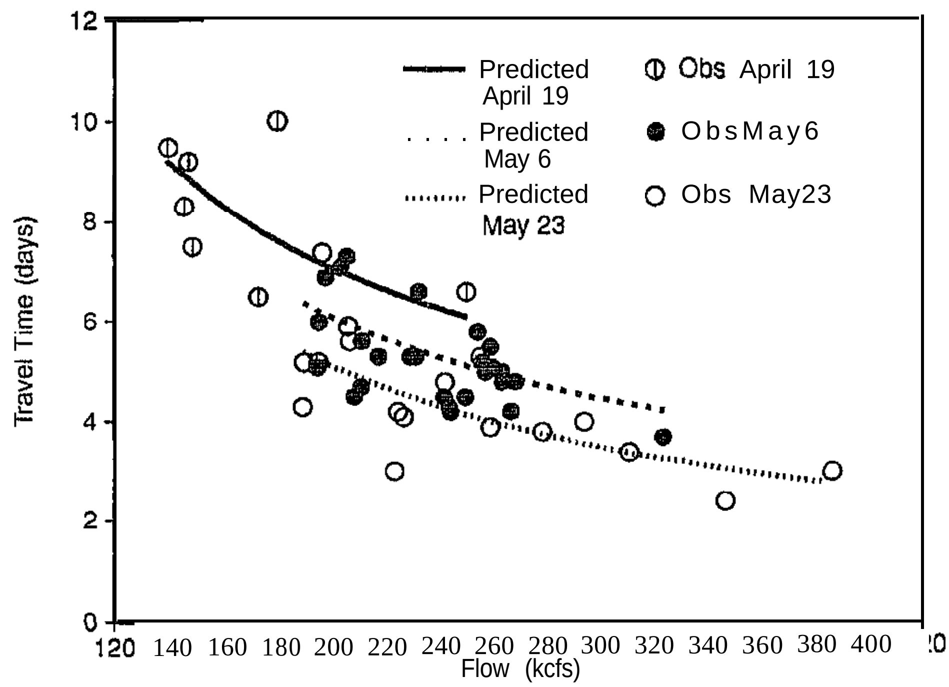


Figure 43. Relation between yearling chinook travel time and flow and date in the McNary Dam to John Day Dam index reach.

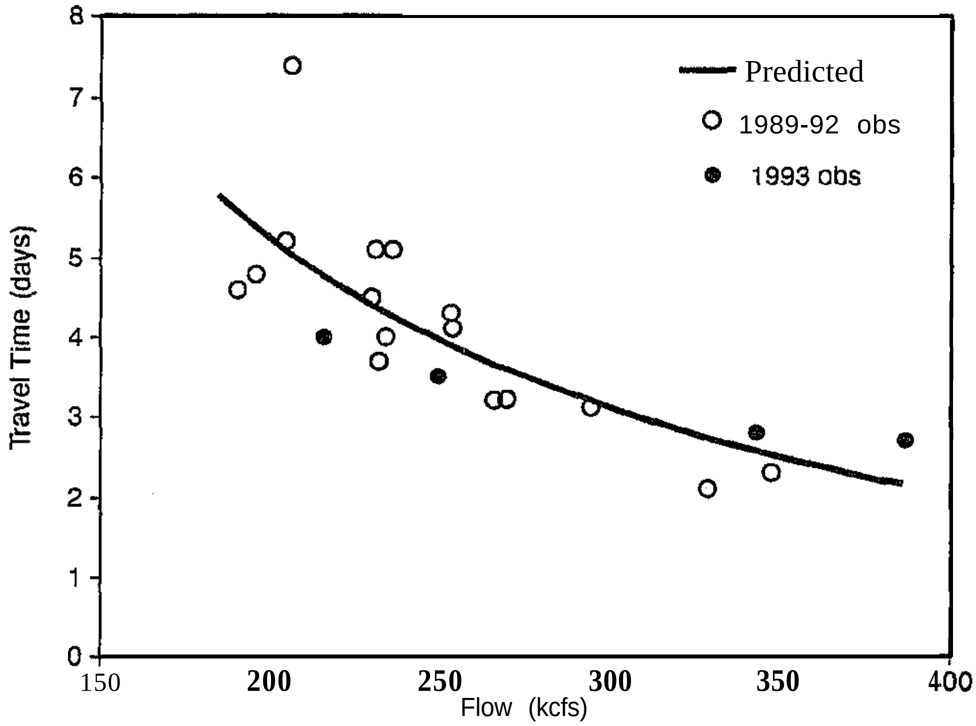


Figure 44. Travel time/flow relation for steelhead in the McNary Dam to John Day Dam index reach based on 1989-93 data.

average less than 1 day shorter for steelhead than yearling chinook in the index reach at any flow. With such a strong travel time/flow relation for steelhead, the addition of a smoltification surrogate variable (either TEMP or SERIAL) did not significantly improve the predictive model (Table 36).

D. Summary and Conclusions

Traps to Lower Granite. In 1993 the Snake River Drainage had higher flows than had been observed in recent drought years. The traps were removed from operations during the high flow event, but groups released into the river indicated how fish were traversing the Lower Granite Pool under these improved flow conditions. Fish travelled faster across the reservoir than had been observed in recent years. Hatchery and wild stocks travelled similarly.

Little Goose Dam to McNary Dam. The benefit associated with the higher flows of 1993 was reflected in the decrease in travel time seen this year. Steelhead travelled through the Snake River in about half the time it took during 1992. Chinook passed through the Snake at a rate that was about 30% faster this year compared to 1992.

Rock Island Dam to McNary Dam. The mid-Columbia River was characterized in 1993 by extremely low April flows (monthly average of 54 kcfs), followed by slowly improving flows through mid-May, and higher than average flows the latter half of May (averaging 175 kcfs). These conditions produced a wide range of flows and associated smolt travel time estimates this year. Significant travel time relations with flow and smoltification related variables were obtained for yearling chinook, steelhead, and sockeye in the Rock Island Dam to McNary Dam index reach using data from 1993 along with data from available prior years.

McNary Dam to John Dav Dam. Similar to other reaches, an increasing flow pattern occurred in the lower Columbia River, producing flows under 150 kcfs during much of April and flows above 300 kcfs during the latter half of May. This produced a wide range of flows and associated travel time estimates for 1993. These data, along with data since 1986 for yearling chinook and since 1989 for steelhead, produced significant flow/travel time relations for John Day pool.

V. 1993 HATCHERY RELEASES

In 1993, the production of hatchery fish released above Bonneville Dam into the Columbia River basin streams was reduced by 8% from the 1992 hatchery production level. About 81.3 million juvenile salmonids were released from federal, state, and tribal fish hatcheries in 1993 (Table 37). Appendix G gives the individual hatchery release information for each individual agency. Overall, the reduction of Snake River spring and summer chinook releases accounted for the largest percentage of the reduced 1993 release totals.

Table 37. Summary of hatchery releases by species and release area for 1993[a]

Species	Snake River	Mid-Columbia	Lower Columbia	Total
Spring Chinook	4,634,000	4,171,000	7,449,000	16,254,000
Summer Chinook	982,000	1,800,000	0	2,782,000
Fall Chinook "Brights"	967,000	8,858,000	8,879,000	18,704,000
Fall Chinook "Tule"	0	0	21,973,000	21,973,000
Coho	0	1,168,000	7,759,000	8,927,000
Sockeye	0	355,000	0	355,000
Steelhead	10,080,000	1,369,000	900,000	12,349,000
TOTAL	16,663,000	17,721,000	46,960,000	81,344,000

[a] 1993 **data are** preliminary; includes revisions through **12/15/93.**

A factor which has affected, and will continue to affect, hatchery releases is the listing of several wild chinook races and stocks under the Endangered Species Act. In 1993, Snake River salmon and steelhead hatchery release dates were altered, generally delayed, to reduce impact of hatchery releases on wild spring and summer chinook salmon. The 1993 NMFS Biological Opinion regarding release of hatchery fish was not received from Washington D.C. prior to the normal hatchery dates, so fish were held and not released until early to mid-April at non-federal hatcheries in both the Snake and mid-Columbia rivers. Although presumptive, it does not appear that this had negative effects on the survival of these hatchery stocks, at least not in the juvenile phase of their life.

Lower Columbia River

Lower Columbia River hatcheries released about 47 million fish in the McNary Dam to Bonneville Dam reach of the Columbia River. Nearly half, 22 million, were subyearling tule fall chinook from Spring Creek Hatchery, which were reared and released into the Bonneville pool. In addition, about 8.9 million upriver bright fall chinook, mostly subyearling fish, were released into the Umatilla, Klickitat, and Little White Salmon rivers, About 7.45 million spring chinook salmon were released into the Umatilla, Klickitat, Little White and Big White Salmon, Wind, Hood, and Deschutes rivers during the

1993 spring or 1992 fall. Coho salmon production of nearly 7.5 million was increased about one million above the 1992 total. These fish were released into the Umatilla, Klickitat, and Little White Salmon rivers. Both summer-run and winter-run steelhead are released into this reach, with the winter steelhead released only in the Bonneville pool tributaries. About 900,000 winter-run and summer-run steelhead were released into the Umatilla. Klickitat, Big and Little White Salmon, Hood, Wind, and Deschutes river, and a small number in Rock Creek, near Stevenson, Washington. The John Day River remains a designated stream for "wild" fish only, *i.e.* no hatchery fish are planted in that stream. As *in* previous years, there were no sockeye or summer chinook planted in this reach. A portion of the hatchery chinook production was marked with fin clips or tag(s) which would distinguish them from the wild chinook in the river system.

Mid-Columbia River

Mid-Columbia hatcheries released about 17.7 million anadromous salmonids in the reach from above McNary Dam to Chief Joseph Dam, This total was very near the 1992 hatchery release total. Releases of subyearling fall chinook from Priest Rapids Hatchery (mainstem release) and others into the Yakima River accounted for most of the 8.9 million total fall chinook production, and was nearly 1.7 million greater than in 1992. All fall chinook above The Dalles Dam are considered upriver brights. Over four million spring chinook salmon from the Leavenworth Hatchery complex were released into the Wenatchee. Entiat, and Methow rivers. Most of these spring chinook were yearling fish. Summer chinook releases were about 1.8 million, which was below the normal release total; however, a larger portion than previous years were released as yearling rather than subyearling fish. Summer chinook were released into the Wenatchee, Okanogan. Methow, and mainstem Columbia (just below Wells Dam) rivers. Sockeye salmon were reared in Lake Wenatchee and released in the fall, and Wenatchee stock sockeye also planted in Lake CleElum during the late summer, fall, and spring. Juvenile sockeye planted in 1992 fall and 1993 spring were near 355,000. 1993 was the final scheduled release of hatchery sockeye into CleElum Lake. An initial release of Osoyoos stock sockeye from Methow Hatchery was made into Osoyoos Lake in late April. Those fish will likely not migrate from the lake until 1994. About 1.2 million coho salmon were released into the mid-Columbia River at Turtle Rock and into the Yakima River. This was the last scheduled plant of coho from Rocky Reach Hatchery to the Turtle Rock site, while the Yakima River releases will continue. Summer steelhead releases totaled about 1.4 million, and these were planted into the Wenatchee, Methow, Okanogan. Entiat, mid-Columbia (at Ringold Hatchery), and the Yakima rivers. Only a portion of the chinook released from mid-Columbia hatcheries were marked to distinguish them from wild chinook.

Snake River

In the Snake River reach, 16.7 million juvenile anadromous salmonids were released from hatcheries in 1993. This total was at least 4.5 million less than either the 1991 or 1992 total. Spring chinook releases were near 4.6 million. about one-half the previous two years' average of nine million per year. Hatchery releases were planted into the Salmon, Clearwater. Grande Ronde, Tucannon, and Imnaha basins. All hatchery spring, summer, and fall chinook were marked with a tag, a fin clip, or a combination of the two. Spring chinook at state hatcheries were released in early to mid-April in 1993. about two to four weeks later than normal. Summer chinook from McCall and Pahsimeroi hatcheries were released at similar time frames as the spring chinook, with the total from these two hatcheries at slightly below one million. Those fish were released into the South Fork Salmon and Pahsimeroi rivers. In the FPC database, the Imnaha fish were listed as spring rather than summer chinook. Fall chinook were released from Lyons Ferry Hatchery into the main Snake River. Most (760,000) were released as yearling fish in April, with the remaining 207,000 released as subyearling fish in late June. This release total is increased over the past few years. Hatchery summer-run steelhead releases were above 10 million for the 1993 migration year. These fish were also released a little later than normal, due to the Opinion hatchery releases in the Snake River basin. Summer-run steelhead. both "A" and "B" strains, were released in main tributaries and streams in the Grande Ronde basin and Imnaha basin, Salmon basin, Clearwater basin, Tucannon and Asotin rivers, and the main Snake River at select sites.

A. Historical Summary: Hatchery Releases in Columbia River Basin - 1980 to Present

Prior to the Fish Passage Center's efforts to consolidate Columbia River basin hatchery releases into one database, hatchery release information was somewhat scattered and difficult to obtain. At present, each fishery or tribal agency is contacted to obtain pre-release information (January through March), which is then updated throughout the season, and the data are entered in the FPC main computer. The information received from the hatchery release coordinators, hatchery managers, or mark coordinators include: agency, hatchery, brood year, migration year, number of fish released and size (#/lb.), release date(s), release site, river name. and appropriate mark codes where possible. The FPC assigns an identification code to each of the specific hatchery releases. General comments are included with each record and include information such as: coded wire tag numbers and code, pertinent fin clips, and other information deemed necessary, such as "unfed fry release" or "direct stream release." Annually, FPC staff attempt to consolidate hatchery releases above Bonneville Dam as timely and accurately as possible. since management decisions relating to fish abundance in the reaches (both hatchery and wild) play an important role in the use of flow augmentation, spill requests, and fish migration through the reaches. The hatchery releases below Bonneville Dam are updated on a monthly basis throughout the year. Final release data are often not available as a whole until the responsible agencies make all final corrections and updates for the year, which is generally between February and April of the following year. All hatchery release schedules have been made available to interested parties upon request, and hatchery release schedules above Bonneville Dam are generally included in the FPC annual report. Fish Passage Center database files of Columbia and Snake River hatchery releases were reviewed to ascertain what changes have occurred since 1980. We have taken the approach of separating hatchery releases into four major reaches: (1) Snake River from the mouth upstream to Hells Canyon Dam. and all tributaries; (2) Mid-Columbia River and tributaries from McNary Darn to Chief Joseph Dam: (3) Lower Columbia River and tributaries from Bonneville Darn upstream to McNary Dam; and (4) below Bonneville Dam: mainstem Columbia River and tributaries from Bonneville Dam downstream to the Pacific Ocean. Figures 45 to 48 depict release totals by year and reach and for each species and race; for example, spring. summer, and fall chinook. Also, the migration year may vary from the release year. For example, spring chinook which are released into the Salmon River in September or October of 1992 would be classified as a 1993 migration year migrant, since the majority of the release would begin their downstream migration the following spring. All fish released below Bonneville Dam are classified on a calendar year; for example, a November release in 1992 would be noted as migration year 1992.

By 1980, all mainstem dams were in place except for Bonneville Dam Powerhouse II. Mitigation for the Snake River projects was just beginning to take shape under the umbrella of the Lower Snake River Compensation Plan, which called for several new hatcheries and acclimation facilities in the basin. In addition, as a result of hearings on U.S. *vs Oregon*, some hatchery production releases were changed from sites below Bonneville Dam to release sites above Bonneville. As a result of other settlements in the mid-Columbia mitigation, hatcheries have recently been completed and will be at full capacity in the near future. These factors have greatly affected numbers of fish released in the basin, as well as the location and stock composition of fish planted in the river systems. Old records or reports were reviewed to assess possible reasons why hatchery release totals might radically vary on a year-to-year basis. In addition, the FPC notes such items as new hatcheries or release facilities that affected hatchery release totals.

Throughout the past decade of hatchery releases in the Columbia River basin above Bonneville Dam, total releases from all species have ranged between 60 and 88 million fish (Figure 45). During the 1980-82 period, total hatchery production was less than 70 million fish, with fall chinook production from the lower Columbia River (mainly Spring Creek, Little White Salmon, and Klickitat hatcheries) comprising the bulk of those fall chinook releases. From 1983 through 1987, hatchery production increased above McNary Dam: however. the 19851987 releases of fall chinook from the lower Columbia River decreased, yielding approximately the same total production. From 1988 to present. hatchery production has ranged between 78 and 88 million juvenile salmonids released above Bonneville Dam.

Many hatcheries have been re-evaluating their programs in an effort to improve the quality of fish released. From a historical prospective. hatcheries were sometimes operated with release totals in mind. In some cases. this resulted in different stocks and races of salmonids planted from the basin hatcheries into streams. New hatchery policies are now in place that regulate what stocks of fish can be planted into the various streams. Steps are being taken to evaluate holding densities, timing of releases, size at release, and other parameters which should improve the quality of fish **and** survival of hatchery salmonids in the region.

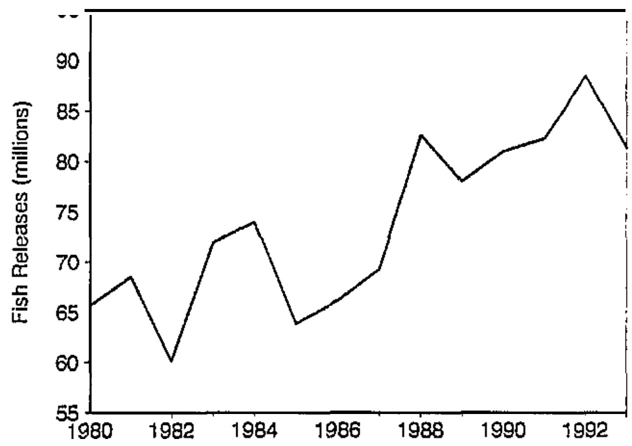


Figure 45. Hatchery releases of **anadromous salmonids** above Bonneville Dam from 1980 through 1993.

Snake River Basin

From 1980 through 1988, rive new hatcheries in the Snake River basin were completed under the Lower Snake River Compensation Plan, with the final one completed after 1990. As shown in Table 38 and Figure 46, hatchery releases of steelhead and chinook totaled near IO million annually from 1980-1983; near 15 million each year 1984-1986; and greater than 20 million annually from 1987 to 1992. Hatchery spring chinook released in 1993 were reduced nearly five million from the 1992 total, and this accounts for the reduction to near 16.6 million total for this year. In 1988 and 1990, over 27 million chinook and steelhead were planted in the Snake River basin, with the lowest production (7.2 million) recorded in 1982. In future years, it is likely that there will be hatchery production releases to supplement the wild populations of sockeye salmon in the upper Snake basin. Presently, some juvenile sockeye salmon are being reared to adults to increase chances for restoring sockeye to the Stanley Basin lakes.

Spring Chinook - Hatchery spring chinook generally are reared to smolt size (about 1.7 yrs.) and released in the early spring. In some cases. subyearling fish are reared to near smolt size and released. Numbers listed will include both yearling and subyearling fish, as well as those fish released in the fall to migrate out during the next spring freshet, New hatcheries that came on-line or increased chinook production in the 1980's and 90's include: Lookingglass complex, Dworshak complex, Clearwater, and Sawtooth; the Pahsimeroi Hatchery now raises summer chinook (formerly they reared spring chinook).

From 1980-82, about 3.5 million chinook were planted in the basin, with the bulk of these fish released from Rapid River Hatchery into the Little Salmon River drainage near Riggins, Idaho. From 1983-86, about 6 million chinook were released annually into the Snake River basin. From 1987 through 1992. 8-10 million yearling and subyearling spring chinook were released annually from IDFG, ODFW, WDF. and USFWS hatcheries. Unless further hatchery mitigation is required, hatchery production should remain stable for the next few years.

The 1993 release total was 4.6 million, about half the number of the 1986-92 period. Unless there are changes due to ESA requirements, the 1994 spring chinook releases will be much closer to the normal release total of recent years since 1986. It should be noted that all spring chinook released in the Snake

River basin will be marked to distinguish the hatchery fish from the wild/natural population. For the 1994 release, an adipose clip or a fin clip will indicate that a fish is from a hatchery. In previous years, all chinook with an adipose fin clip carried a coded wire tag.

As depicted in Table 38, hatchery production in the Snake River basin has increased by a factor of nearly three since the early 1980's. There has not been a corresponding three-fold increase in adult production.

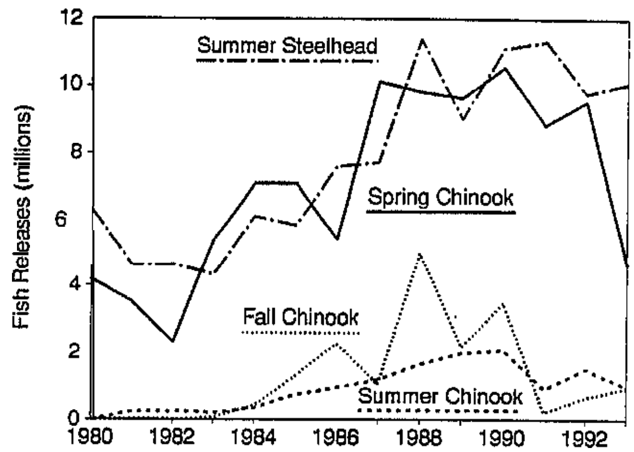


Figure 46. **Snake** River hatchery releases by **race** and **species 1980-1993.**

Table 38. **Hatchery** release totals for **the Snake** River reach, **1980-1993.**

Year	Spring Chinook	Summer Chinook	Fall Chinook	Summer Steelhead	Snake River Reach Totals
1980	4,176,000			6,328,000	10,504,000
1981	3,492,500	249,500		4,624,000	8,366,000
1982	2,319,000	264,000		4,638,000	7,221,000
1983	5,393,500	197,500	79,000	4,310,500	9,980,500
1984	7,076,708	356,673	427,191	6,122,220	13,982,792
1985	7,086,889	781,405	1,317,921	5,849,153	15,035,368
1986	5,408,335	982,443	2,271,520	7,586,945	16,249,243
1987	10,120,900	1,217,000	1,060,500	7,717,200	20,115,600
1988	9,812,000	1,659,000	4,981,000	11,388,252	27,840,252
1989	9,632,161	1,991,300	2,153,882	9,008,783	22,786,126
1990	10,543,015	2,090,500	3,480,110	11,115,889	27,229,514
1991	8,806,172	936,100	224,660	11,330,844	21,297,776
1992	9,516,871	1,507,400	689,601	9,754,415	21,468,287
1993	4,633,546	982,300	966,793	10,079,817	16,662,456

Summer Chinook - Hatchery summer chinook were planted in the South Fork of the Salmon River in the early 1980's. McCall Hatchery continues to collect adult brood from the South Fork of the Salmon River and releases fingerling smolts in the same river. In addition, Pahsimeroi Hatchery plants summer chinook into the Pahsimeroi River on an annual basis, if enough adult brood stock are captured. About two million summer chinook were released in 1989 and 1990, the highest totals to-date. Until 1984, summer chinook releases were less than 500,000 per year, and then increased to more than one million per year under most conditions. Likely hatchery summer chinook totals will not increase above two million in the near future. Adult returns from these releases are still minimal. Most summer chinook juveniles are released as yearlings, with some subyearling fish planted in areas with good habitat.

Fall Chinook - Hatchery fall chinook propagation began with plants from Lyons Ferry Hatchery in the mid-1980's. The release totals increased from 79,000 in 1983 to nearly five million in 1988. Reduced numbers of Lyons Ferry stock fish have been released during the past three years, ranging from 224,000 to 967,000. This is because only Lyons Ferry stock brood may be released into the Snake River. Both yearling and subyearling fish have been released over the years, with the yearling fish generally released in mid-April and the subyearling fish released in June. All fall chinook juveniles are fin clipped and tagged with a coded wire or elastomer eyelid tag to aid in identifying Snake River fish. Until numbers increase, fish are released at Lyons Ferry Hatchery and below Ice Harbor Dam.

Steelhead - Production of hatchery steelhead in the Snake River basin has been fairly strong throughout the years, with the minimum release total being 4.3 million in 1983. Annual release totals ranged between four to six million between 1980 and 1985, rose to nearly eight million in 1986 and 1987, and have ranged between nine and eleven million between 1988 and 1993. Lyons Ferry (WDW), Irrigon (ODFW), and Magic Valley (IDFG) are all Lower Snake River Compensation Plan hatcheries, which came on-line in the mid-1980's. Associated satellite acclimation facilities are located on the Tucannon, Cirande Ronde, and Touchet rivers, and at the Big Canyon, Wallowa, and Big/Little Sheep facilities located on the Oregon section of the Grande Ronde and Imnaha rivers. Steelhead from Magic Valley are planted at selected sites in the Salmon River drainage. In addition, existing facilities such as Dworshak, Hagerman, and Niagara Springs hatcheries continue to outplant large numbers of fish into the Clearwater. Salmon, and mainstem Snake rivers.

Mid-Columbia River Basin

Hatchery production in the mid-Columbia River reach has been relatively consistent over the years since 1982. Totals ranged from 17.2 to 24.9 million fish annually, with 1984 providing the peak year of nearly 25 million fish releases. Nearly 5 million additional fall chinook were released that season to raise that year's total well above the other seasons. Table 39 and Figure 47 show the hatchery release totals from 1980 through 1993.

Spring Chinook - Production of spring chinook in the mid-Columbia River basin has been fairly

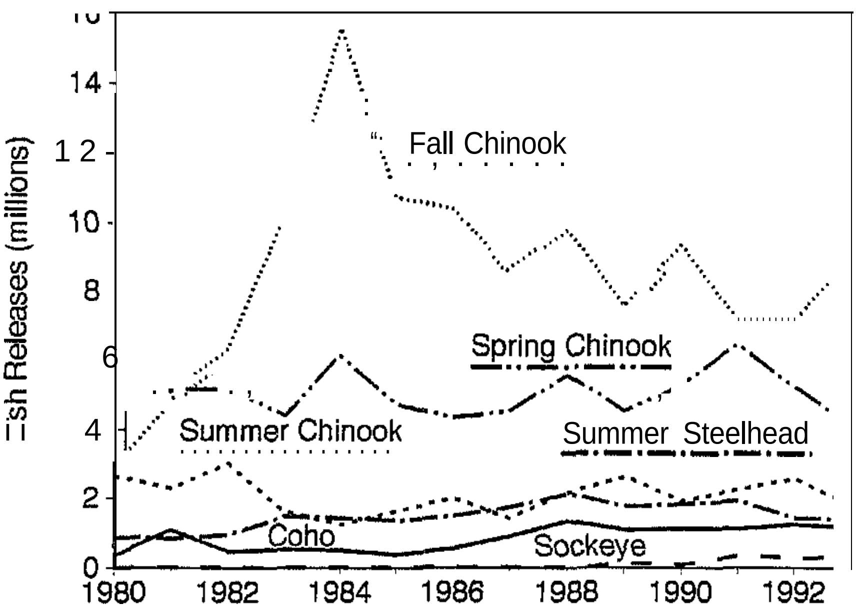


Figure 47. Mid-Columbia reach historical hatchery releases by race and species for 1980-1993.

consistent throughout the 1980's and into the 1990's; release totals have ranged from a low of 4.2 million in 1993 to a high of 6.5 million in 1991. Generally, yearling chinook are released in mid-April and trigger the start of the spill program at the mainstem dams. Subyearling spring chinook have been released from Entiat and Leavenworth hatcheries to supplement the yearling chinook program. Only a portion of the spring chinook are marked with clips or tags at mid-Columbia hatcheries. The Chiwawa and Methow hatcheries (both managed by WDF) were completed in the 1990's. Winthrop, Entiat. and Leavenworth hatcheries (USFWS) have operated throughout the past 14 years. All spring chinook produced in mid-Columbia River hatcheries are released on-site. Ringold Hatchery (WDF), located in the Hanford Reach, now releases only yearling spring chinook. During the 1980's, they released fall chinook during some years. It is likely that the spring chinook production will continue at near the same level. or possibly increase, when Methow and Chiwawa stations are at full capacity.

Summer **Chinook -** Summer chinook production in the 1980's was generally from Wells Hatchery, but beginning in 1991 with the completion of the Eastbank Hatchery Complex (which includes satellite facilities at Dryden (Wenarchee River), Similkameen Pond (Similkameen River), and Carlton (Methow River)), production will eventually be at full capacity of nearly 1.9 million yearling summer chinook. Wells Hatchery production would be in addition to the Eastbank Complex releases of summer chinook. At present. the Eastbank Complex releases yearling summer chinook, while Wells Hatchery produces both yearling and subyearling summer chinook. A fairly high number of the yearling migrants do not actively migrate until mid- to late May, even though they have opportunity to migrate downstream from mid-April with the volitional releases at the hatchery sites. The subyearling hatchery chinook generally are released in June. About one-half the hatchery production is marked annually with both a fin clip and 3 CWT.

Fall Chinook - From 1980 to 1982, fall chinook production in the mid-Columbia basin averaged about 4.9 million subyearling chinook released each year. Fall chinook production peaked in 1984, when 15.5 million up-river bright fall chinook were released. Since 1986, release numbers have been more stable. with over 8 million average per year. Priest Rapids Hatchery (mainly) and in some years Ringold Hatchery, contributed to this large increase of fall chinook produced from 1983 to 1986. In recent years, about one to two million subyearling fall chinook have been released into the Yakima River. In 1993, production of subyearling fall chinook began at Rocky Reach Hatchery with the first release of 1.6 million in June 1993. Priest Rapids Hatchery reduced its pond loading from near 10 million in 1984, to its present capacity of near six million fish in recent years. The bulk of the releases of fall chinook have been subyearling. fish released from May to late June. Unlike the Snake River, only part of production releases are marked with tin clips or coded wire tags.

Steelhead - The production of A-run steelhead was less than one million annually from 1980 to 1982. Since then, annual steelhead production peaked in 1988 at 2.1 million, and were near 1.4 million annually the past two seasons. Future steelhead production totals will not substantially change, as all hatchery facilities are operating near capacity. A reduction in the number of fish planted in the Yakima River has occurred through time, with releases currently near 30,000 per year. Eastbank Hatchery has been on-line since 1990 and now rears all the steelhead destined for the Wenatchee River, Entiat River. and Turtle Rock facility. Wells Hatchery continues to supply fish to the Methow and Okanogan River basins, while Ringold Hatchery releases fish into the Hanford Reach of the Columbia River. All hatchery steelhead are adipose fin clipped to distinguish them from wild/natural migrants.

Coho - Coho have been planted in the mainstem Columbia and Yakima rivers throughout most of this time frame (1980-1993). Since 1987, numbers released into both areas have been fairly stable, in the range of 0.9 to 1.3 million. 1993 was the final release of coho from Rocky Reach Hatchery, and that will reduce future plants into this reach to near 800,000 on an annual basis. Adult return rates of hatchery reared coho have been extremely poor in the mid-Columbia River. Production releases of coho planted in the Yakima River are presently from Cascade Hatchery (ODFW).

Sockeye - Production of sockeye salmon has been a recent venture after an unsuccessful beginning in earlier years. Since 1989. release totals have ranged from about 100,000 to 300.000. The adult brood stock were captured at Tumwater Dam. These fish were held in net pens in Lake Wenatchee and spawned. the offspring raised to smolt-size. and planted in the CleElum River or Lake in the Yakima basin, or in Lake Wenatchee as part of the Eastbank Hatchery program. At present, there are no plans to continue planting fish into the CleElum River/Lake drainage. This will reduce numbers of hatchery

Table 39. Hatchery release totals for the mid-Columbia **River** reach.

Year	Spring Chinook	Summer Chinook	Fall Chinook	Summer Steelhead	Coho	Sockeye	Mid-Columbia Reach Totals
1980	4,788,000	2,638,000	3,327,500	873,000	353,000		11,979,500
1981	5,161,000	2,271,500	5,115,500	848,000	1,089,500		14,485,500
1982	5,186,500	2,981,000	6,297,500	974,500	482,500		15,922,000
1983	4,369,000	1,609,000	10,276,500	1,471,500	536,000		18,262,000
1984	6,129,744	1,240,865	15,548,324	1,422,329	517,100		24,858,362
1985	4,715,729	1,630,322	10,689,637	1,344,712	388,790		18,769,190
1986	4,336,047	1,992,057	10,385,476	1,494,630	554,563		18,762,773
1987	4,535,000	1,413,000	8,583,500	1,740,200	911,500		17,183,200
1988	5,542,000	2,144,500	9,769,500	2,117,000	1,329,500		20,902,500
1989	4,508,517	2,597,099	7,571,364	1,751,287	1,084,753	107,299	17,620,319
1990	5,292,566	1,912,708	9,338,978	1,822,491	1,118,138	88,978	19,573,859
1991	6,455,029	2,258,293	7,185,575	1,913,905	1,125,130	355,638	19,293,570
1992	5,250,209	2,551,616	7,211,100	1,427,454	1,245,807	281,707	17,967,893
1993	4,171,286	1,800,199	8,857,582	1,368,682	1,167,694	354,595	17,720,038

sockeye in the mid-Columbia River by approximately one-half. It appears that the Wenatchee project will continue supplementing juvenile fish into the Lake in the fall. Adult returns from the 1989 brood are promising. In 1993, a hatchery program to increase Okanogan stock sockeye was initiated and will be continued in future years.

<u>Lower Columbia River Basin</u>

During the past decade, hatchery production fluctuated substantially in the Bonneville pool to McNary Dam section of the Columbia River (Table 40 and Figure 48). This was primarily due to fall chinook production in that reach of river. From 1980 through 1983, hatchery releases averaged over 40 million per year. From 1984-90, hatchery release totals ranged between 30 to near 38 million fish per year. Since 1991, release totals ranged from near 42 million to 49 million. In all years, fall chinook comprised the majority of fish released in a given year. Some changes over the past years that have occurred are: Little White Salmon Hatchery does not release tule fall chinook as it once did, but instead releases upriver bright fall chinook; Spring Creek Hatchery tule production is somewhat reduced from earlier years: a major effort has been placed on renovating the Umatilla River, with hatchery plants of both yearling and subyearling spring and fall chinook, yearling coho, and summer steelhead. The Klickitat Basin Plan may call for additional changes for production releases in future years. Overall, this river reach increased hatchery production for most species. and reallocated tule and bright fall chinook production.

Spring Chinook - Production of spring chinook has been increasing since the early 1980's, when between four to five million were released per year. From 1984 through 1991, about 5.4 to 6.6 million spring chinook were released throughout the reach. In 1992, the peak number for this time frame occurred. with 8.6 million planted, followed by 7.5 million in 1993. These numbers include both yearling and subyearling fish. There are efforts to re-establish spring chinook into the Umatilla River with acclimation ponds as well as direct stream plants in the basin. Also, the Hood River drainage has received considerable plants of yearling chinook on an annual basis over the past 5 to 6 years. The Big White Salmon River is now planted with spring chinook each spring and fall. Throughout this time frame, the Wind, Klickitat, Little White, and Deschutes rivers have had consistent hatchery production releases.

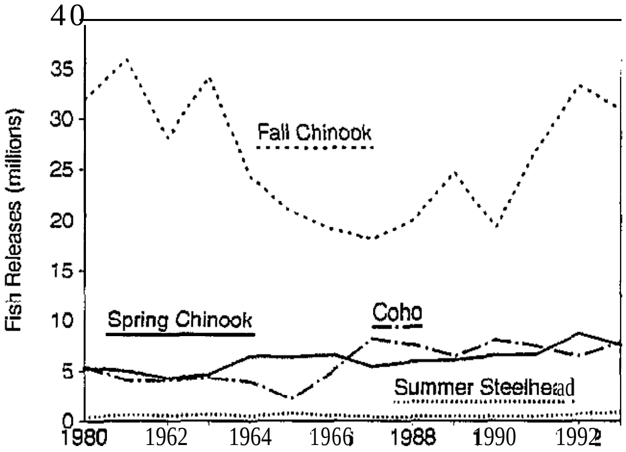


Figure 48. Lower Columbia River historical hatchery releases by race and species for 1980-1993.

Fall Chinook - Hatchery releases of tule and upriver bright fall chinook have varied greatly in number as well as percentage of each released. Tule stock fall chinook originate from Spring Creek Hatchery (USFWS), with the up-river bright stocks raised in other hatcheries such as Bonneville, Irrigon or the new Umatilla (ODFW), Klickitat (WDF), and Little White Salmon (USFWS). From 1980-83, production of upriver bright and tule fall chinook averaged greater than 30 million per year. From 1984-90, hatchery production declined (range from 18.1 to 24.7 million), primarily due to depressed numbers of tule fall chinook available for stocking. From 1991-93, numbers ranged from 27 to 33 million per year. This will likely be near the scheduled release totals for the next few years.

Steelhead - Both winter and summer steelhead are released in this reach of the river, with the 1993 total of near 94.000 winter run being the highest on record. These winter run fish are presently being planted in only the Bonneville pool tributaries. Summer run steelhead plants have been fairly consistent throughout the years, ranging from 433.000 to 806.000 per year. The completion of the Umatilla Hatchery has resulted in increased plants of summer steelhead in the Umatilla River.

Coho - Releases of hatchery coho ranged from 2.2 to 5.5 million from 1980 through 1986. From 1987 to present. release totals ranged from 6.4 to 8.1 million annually. The Klickitat River receives nearly one half the total released with the Little White Salmon and Umatilla rivers receiving the remainder of the juvenile coho planted in this reach. Hatchery releases in the Umatilla River appear to

Table 40. **Hatchery** release totals for the lower Columbia River reach.

Year	Spring Chinook	Fall Chinook	Summer Steelhead	Winter Steelhead	Coho	Lower Columbia Reach Totals
1980	5,338,500	31,896,000	433,500		5,495,500	43,163,500
1981	5,014,000	35,936,500	609,500		4,075,500	45,635,500
1982	4,295,500	28,093,500	489,000	33,000	4,097,500	37,008,500
1983	4,635,000	34,141,500	631,000		4,306,500	43,714,000
1984	6,398,645	24,256,048	443,536	90,589	3,905,834	35,094,652
1985	6,344,905	20,804,201	728,282	10,008	2,162,846	30,050,242
1986	6,581,373	19,073,721	491,287	75,340	4,883,127	31,104,848
1987	5,383,500	18,081,000	380,000	24,000	8,092,000	31,960,500
1988	5,884,000	19,987,000	419,000	28,000	7,505,500	33,823,500
1989	6,031,894	24,716,262	494,250	28,659	6,401,762	37,672,827
1990	6,499,389	19,271,587	412,587	45,893	7,950,268	34,179,724
1991	6,621,577	27,157,783	493,188	68,434	7,381,693	41,722,675
1992	8,623,797	33,267,850	673,146	45,855	6,405,141	49,015,789
1993	7,448,804	30,851,923	805,865	93,901	7,758,690	46,959,183

be successful, based upon the number of adult fish that are returning to spawn from the hatchery plants. It is likely that this program will be continued,

Below Bonneville **Dam**

Our database covers the below Bonneville Dam reach of the Columbia River from 1987 to the present (Table 41). In these years, hatchery production was fairly consistent, with the exception of fall chinook and coho, which tend to vary considerably based on the adult returns for the year and resulting offspring. Numbers varied from near 104 million to 118 million during the seven years. It should be noted that 1993 releases are still being updated and may bring that total slightly higher. Hatcheries below Bonneville Dam generally release from 100 to 120 million fish annually. In the past seven years, there have been no additional hatcheries established below Bonneville Dam. Most facilities that are now operating have been in existence and on-line for many years.

Spring Chinook - Presently, spring chinook are released into most of the larger river tributaries in this reach. including the Willamette, Sandy, Cowlitz, Lewis, and Kalama river drainages. Release totals have ranged between 9.5 to 13.2 million on an annual basis, comprised of mostly yearling chinook, with some subyearling fish to supplement the yearling plants. Excellent returns of adult fish have resulted from some of the hatchery plants, particularly in the Willamette River basin. Most of the yearling plants

Table 41. **Hatcherv** release **totals** for the Columbia River reach below Bonneville Dam.

Year	Spring Chinook	Summer Chinook	Fall Chinook	Summer Steelhead	Winter Steelhead	Coho	Lower Columbia Reach Totals
1987	13,172,000	350,000	61,281,500	1,823,500	2,470,734	24,520,000	103,617,734
1988	9,688,500		76,955,000	1,409,000	2,181,500	21,095,500	111,329,500
1989	11,515,839		78,905,667	1,706,767	2,658,086	23,032,583	117,818,942
1990	9,491,624		68,375,771	1,750,990	2,824,709	23,266,970	105,710,064
1991	13,076,615		74,219,938	1,810,409	2,967,814	25,405,421	117,480,197
1992	12,611,047		65,762,175	1,960,195	2,950,185	33,514,015	116,797,617
1993	10,410,672		60,922,374	1,935,573	2,556,863	25,518,442	101,343,924

are completed by late winter (March plants) and some are completed in November or December.

Fall, Chinook - Over half the total fish released in the tributaries below Bonneville Dam are subyearling fall chinook. Release totals ranged from 60.9 to 78.9 million on an annual basis, and are planted in most of the major rivers in this reach. The largest percentage of the fall chinook below Bonneville are rule stock, with only a few bright stocks in existence. With no new hatcheries planned for fall chinook, these releases should stay fairly consistent through the years, with annual changes based mainly on availability of egg&molts for planting. Major rivers that receive fall chinook plants are: the Willamette, Big Creek. Tanner Creek. Washougal. Cowlitz, Lewis, Kalama, Grays, and Youngs rivers.

Steelhead - In this section of river, winter run steelhead are planted in higher numbers than are the summer run fish. Winter run hatchery plants ranged from 2.2 to 2.97 million annually, while the summer run release groups ranged from 1.4 to 1.96 million annually. One new facility will be coming on-line this next season in Washington, and will release both winter and summer run steelhead into the Lewis River system. Overall, steelhead production below Bonneville Dam will likely increase by a small amount in future years. Steelhead are planted in the Willamette River and its tributaries, Sandy River, and smaller tributaries in the lower Columbia on the Oregon side; the Washougal, Lewis, Elochoman, Grays, Kalama rivers, the Cowlitz River and its tributaries, and other smaller Washington tributaries.

Coho - Coho production in the lower river has been fairly consistent in the last seven years, except for 1992 when 33.5 million were planted. In the other six years, hatchery release totals ranged from 21.1 to 25.5 million. It is anticipated that production of hatchery coho will remain at least near the 25 million total if adequate brood can be taken on a given year. Most of the production is raised to yearling size for release; however, many facilities have subyearling release groups. Juvenile coho are generally considered type-S, or type-N. The type-S coho return as adult fish to the Columbia River in August and September, while the type-N coho return in October and November. Generally, both Type-N and Type-S yearling coho are released between April and June.

Chum - During the past few years, chum salmon fry were released into the Chinook River (near Illwaco, Wa) by Sea Resources Inc. Approximately 500,000 chum were released annually. It is not known if there will be other attempts to increase chum production in the Columbia River, so it appears that similar totals will be released in the Chinook River in the next few years.

VI. 1993 ADULT AND JACK SALMON RETURNS TO THE COLUMBIA RIVER

Fish counting is accomplished at twelve of the thirteen mainstem Columbia and Snake River dams that have adult fish passage facilities (Wanapum Dam is the exception). Fish count data are compiled and incorporated in annual fish passage reports. All races of chinook salmon, coho and sockeye salmon, and steelhead are part of the species observed and counted on their upstream migration. In 1993, approximately 560,000 salmonids were counted at Bonneville Dam. Fish count data are not corrected for fallback or any logistical or physical problem that might have altered adult fish counts at any project.

Spring Chinook Salmon - During 1993, the number of adult spring chinook counted at Bonneville Dam was close to 111.000, the highest total returning to Bonneville Dam since 1986 (Figure 49). This was somewhat surprising since the 1992 jack count at Bonneville was only 2,157. one of the lower counts on record. About 50,000 4-year old spring chinook were estimated in the 1993 run with the remainder composed of 5-year old fish (Matthew Swartzberg, CRITFC, personal communication). Normally, 4-year olds comprise the largest portion of the spring chinook run; however. this was not the case in 1993. Overall survival of the 1988 brood year (1990 migration year) must have been excellent, and that has boosted the adult spring chinook counts during 1992 and 1993.

Passage of adult spring chinook into the mid-Columbia River between McNary and Wells dams was also above average. Mid-Columbia hatcheries obtained adequate numbers of adult fish to meet hatchery needs for the 1993 brood year. The spring chinook count at Priest Rapids Dam total 33,000 (29,000 Priest Rapids ladder count, plus 4,000 hauled above the dam from Priest Rapids Hatchery). The Rock Island count was approximately 20,000 which was a difference of 13,000 adult chinook between the two projects. Preliminary 1993 radio telemetry work conducted NMFS researchers indicated that fish were indeed falling back over the Priest Rapids spillbays (near 18% fallback was recorded). The Priest Rapids and Rock Island count discrepancy has been evident in recent years.

Passage of adult spring chinook salmon into the Snake River based on the Ice Harbor Dam count was about 24,700, which was above the lo-year average, but below the 1985-88 counts at Ice Harbor Dam. Most upstream hatcheries met broodstock requirements for 1993. The majority of this year's adult return into the Snake River was composed of 5-year old fish. The wild spring chinook component in this count is not known. however, redd counts were somewhat increased this year based on spawning ground surveys.

Summer **Chinook Salmon -** Summer chinook runs are confined to the mid-Columbia River and Snake River basins: none are identified as such below McNary Dam. In general, wild juvenile summer chinook from the mid-Columbia migrate as subyearling fish from late May through August. Most hatchery summer chinook programs now release yearling fish. The Snake River summer chinook are composed of yearling migrants which migrate from April through mid-June. Because of the genetic similarities

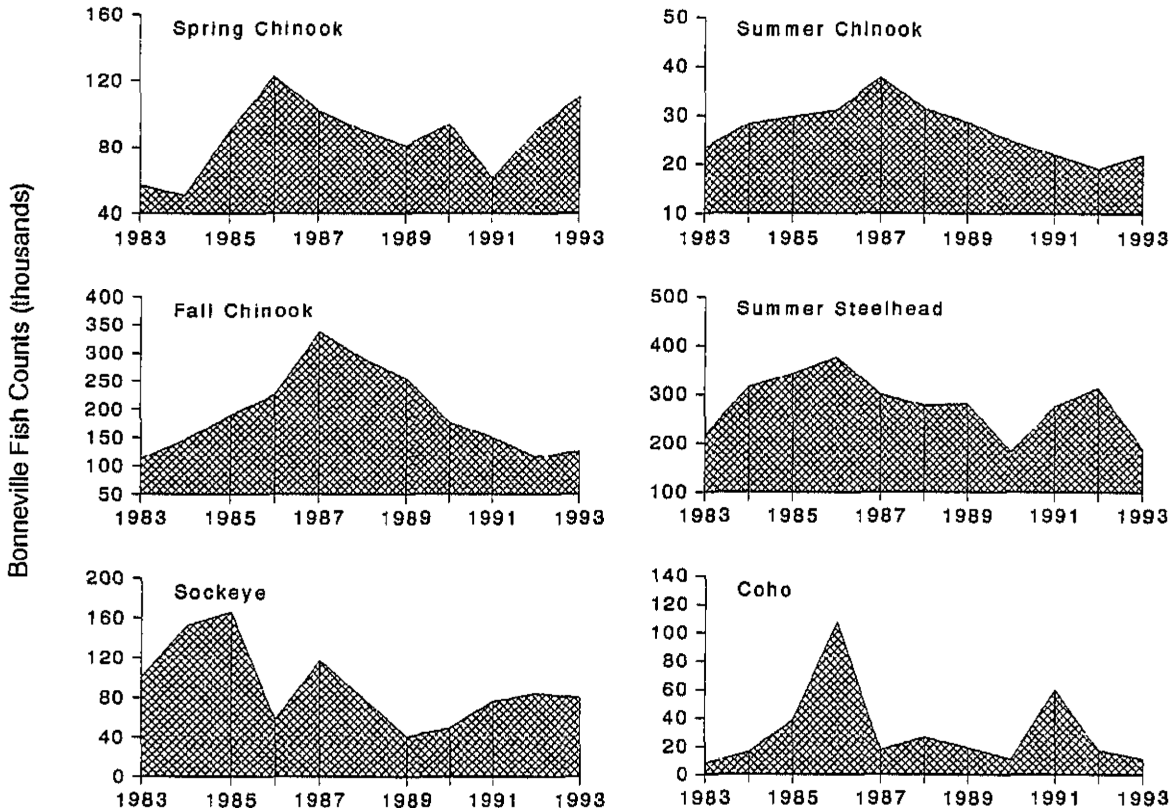


Figure 49. Passage of adult salmonids at Bonneville Dam 1983 - 1993.

between spring and summer chinook in the Snake River basin, NMFS has classified them as one threatened race. The mid-Columbia River summer chinook appear to be more closely related to fail chinook.

In 1993, the count of adult summer chinook at Bonneville totaled 22,045 (Figure 49), with an additional 1,571 jacks. At upstream projects, adult summer chinook counts were well above the 1992 count and above most of the lo-year average counts (McNary Dam and above).

The count of adult summer chinook into the mid-Columbia River was 16,377 with a jack count of 799 at Priest Rapids Dam. Passage totals remained well above the 1992 total at all Mid-Columbia dams. Part of the increase might be due to increased hatchery releases from the new facilities in the Wenatchee and Similkameen rivers. Wild summer chinook are well established in the Wenatchee River with very small numbers remaining in the Methow and Okanogan Basins.

The passage of adult summer chinook into the Snake River was also well above the 1992 count as well as the lo-year average at each Snake River project. The jack count of summer chinook was near record low levels. The 1993 brood year spawning and egg takes met requirements for summer chinook. Wild summer chinook escapement is assumed to be greater than in previous years, but not known. Some hatcheries, e.g. Imnaha Hatchery, pass adult chinook above weirs to spawn in the available habitat. These fish may be composed of hatchery, wild, or native returns. Most wild escapement totals remain severely depleted in the Snake River Basin.

Fall Chinook Salmon - Fall chinook salmon are generally listed as upriver brights or tules based on physical and genetic differences. However, both normally migrate to the ocean as subyearling juvenile fish and return in the late summer and fall to the Columbia River. The tule stock fall chinook are mainly considered as lower river fish, with only Spring Creek NFH producing tule fall chinook above Bonneville Dam. The upriver bright fall chinook salmon migrate longer distances upriver, and their spawning is generally one to two months later than the tule stock fall chinook. Fall chinook returns to Spring Creek Hatchery (tules) and to McNary Dam (brights) are shown in Figure 50.

The adult fall chinook total at Bonneville Dam was near 127,000 for the season, above the 1992 total, but well below the IO-year average (Figure 49). Again, the jack count of fall chinook was well below most other returns (less than 50% of most jack counts on record for the project) in past years.

Most of the adult fall chinook returning above McNary Dam are destined for the Hanford Reach area to spawn, The count of adult fall chinook at Priest Rapids Dam was greater than 7,000 this season, of which about 3,000 passed Rock Island and 1,000 of those passed Wells Dam.

Adult fall chinook salmon are listed as threatened in the Snake River Basin. Most hatchery fall fish returning to the Snake River are from Lyons Ferry Hatchery, with native fish spawning in the mainstem Snake and tributaries. The Ice Harbor count was well below the 1992 and IO-year average; however, the Lower Granite total showed an increase in number from previous years.

Sockeye - Sockeye salmon are mostly of wild rather than hatchery origin. The primary lakes these fish return to include: Wenatchee Lake in north central Washington State and Osoyoos Lake (Canada). Hatchery sockeye are reared and released into Wenatchee, Osoyoos, CleElum (through 1993 only) lakes. In the future, cultured sockeye will be released from Red Fish Lake and potentially other sites in Idaho. The Snake River sockeye are listed as Endangered under the Endangered Species Act.

The Bonneville Dam count was near 80,000 this year (Figure 49) with the Priest Rapids count about 83.000. The Rock Island Dam count was about 66,000 for the 1993 season. A higher percentage of the Rock Island count turned off into the Wenatchee Lake Basin than continued on to the Okanogan Basin.

Sockeye destined for Red Fish Lake in the Snake River remained few in number. Eight adult sockeye were captured at the weir in 1993. A captive broodstock program is currently being used to sequester and rear sockeye smolts, eggs, etc. from various progeny of sockeye. These fish will be raised to adulthood or to migrants. This program will be continued until numbers have sufficiently increased and viable numbers of juvenile migrants can be outplanted, and returning adults increase to the point that 1,000 adult sockeye can become established as natural populations, and become reproductively distinct,

Steelhead - Adult steelhead returns are mainly composed of summer and winter races which return to

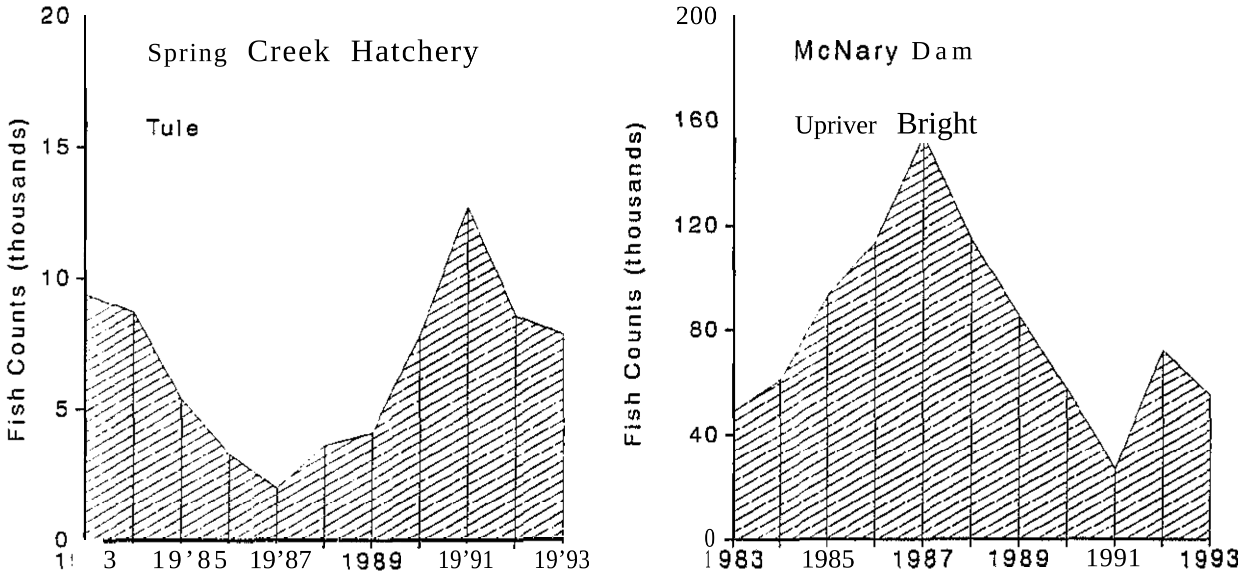


Figure 50. Tule fall chinook returns to Spring Creek Hatchery, and upriver bright counts at McNary Dam, 1983-1993.

the river after spending from one to three years in the ocean. Only a few winter run steelhead are present above Bonneville Dam and generally migrate shorter distances than summer run fish. The summer steelhead migrating above Bonneville Dam generally arrive as early as April with the majority passing from July through October. The early run fish (prior to August 25) at Bonneville are generally one-ocean age fish while two-ocean age fish predominate the later B-run (Aug 26 to end of passage year). In almost all cases. these steelhead migrate upstream and then hold in the main river or tributaries through all or part of the winter, and then spawn in late winter and spring.

This year’s A-run group of steelhead was severely reduced because of the lesser numbers of one-ocean age steelhead in the run. In addition, the B-run group was less than anticipated, so the overall total of fish passing Bonneville was near 188,000, which was at least 100,000 less than either the 1992 or 10-year average (Figure 49). The steelhead run into the Snake and mid-Columbia rivers was near 1/2 and 1/3 the 1992 total steelhead count at Ice Harbor and Priest Rapids dams, respectively.

Coho - Coho passage at Bonneville Dam was just over 10.000 for the year (Figure 49). This was about two-thirds of the 1992 total and well below the IO-year average. Normally, the bulk of these fish are destined for the Bonneville pool: however, it appears that recent plants of hatchery coho into the Umatilla River are taking hold and returning to spawning areas in that river. Other hatchery plants of coho into the Yakima River Basin are increasing more slowly. Adult returns from juvenile hatchery plants into the upper Mid-Columbia have declined steadily over the years. Only five coho were counted at Rock Island Dam this year.

Jack Returns: Spring, Summer, **and Fall Chinook -** The jack or 3-year old spring and summer chinook returns at Bonneville Dam are the lowest on record; only 1,352 spring and 1,571 summer chinook were counted in 1993. At upstream projects, jack returns were also well below average (242 spring chinook and about 100 summer chinook were counted at Ice Harbor), indicating that the 4-year old fish (1990 brood) will be severely reduced in 1994. Jack spring chinook counted at Priest Rapids Dam totaled only 43 fish for the season, which is about one-third of the lowest count on record there. Interestingly enough, the Priest Rapids count of summer jacks is near the IO-year average, while the Snake River count of summer jacks at Ice Harbor Dam was only about 100 fish, which is the lowest on record and less than 30% of the IO-year average. At all projects, this year's jack count of fall chinook was the lowest on record for any of the past 16 years that the FPC has on our data base. For both yearling and subyearling chinook, 1992 was the most disastrous outmigration year for survival to jacks compared to previous years. including the 1977 emigration where severe low water flows also existed during the spring and summer months.

Fish Condition

Annually, adult fish destined for spawning areas above Bonneville Dam, pass from one to nine dams under varying flows, spills, water temperatures, dam operations, and other conditions which will affect passage of fish. Generally, adult salmon observed at Bonneville Dam were in better condition than at the upper darns such as Wells Dam on the mid-Columbia River or Lower Granite on the Snake River. Further injuries may occur during their passage through upstream projects. Problem areas that affected fish condition or health are listed below.

In 1993, high flow and forced spill conditions existed at some mainstem dams from mid-May to mid-June. Higher levels of dissolved gas were present in the reservoirs during this time period. Fish biologists and fish counters observed adult salmon with the skin from the top of the fish's head missing and in some cases part of the cartilage on the head exposed (flesh and skin gone). It has not been determined whether the fish received these head wounds from exposure to the high levels of dissolved gases. or if they might have encountered high shear velocities which caused the skin to peel back and expose the head area. The Lower Granite Dam adult trapping site recorded about 9% of the adult fish from mid-May to early July with this malady. A presentation regarding this topic was given at the August FPAC meeting by Larry Basham, FPC staff member. Ted Bjornn. Project Leader for the adult fish passage study conducted in the Snake River during the past few years, also gave additional information on the problem based on their 1993 radio telemetry study. One general conclusion can be made regarding the condition of salmon that had head "burns", and that is, these fish will likely have reduced survival rates as fungus and other diseases attack this open area on the fish.

At The Dalles Dam, over 300 adult salmonids, comprised mostly of adult steelhead, died due to equipment failure in the east fishway. Diffuser gratings were dislodged from their frames, and fish were trapped in the auxiliary water supply conduit. Other fish were salvaged during the dewatering of the fishway. Most injuries and mortalities were likely caused by direct injury from the fish attempting to find a way out of the auxiliary water channel.

The incidence of harbor seal bites or scratches on salmon has increased during the past few years. These injuries may range from missing scales to flesh wounds. At the Lower Granite adult trapping site. about 18% of the spring and summer chinook were observed with seal bites or scratches. About one-third of these fish had flesh wounds (Jerry Harmon, NMFS, Lower Granite Dam. WA. personal communication, March 1994). Gillnet marks for spring/summer chinook were minimal; less than 5% of the fish had gill net marks based on adult trapping data from Lower Granite Dam. Most were not debilitating injuries, but when flesh wounds occur, this will expose the fish to fungus or other bacteria present in the river system.

VII. ADULT FISH PASSAGE FACILITY OPERATIONS

Adult fish passage facilities or tishways are present at thirteen mainstem Columbia and Snake River hydroelectric projects. Adult fishway refers to the passage route adult fish use to negotiate structures such as dams. These fishways consist of: (1) all equipment and structures which supply water to the fishway; (2) a collection channel or ladder to contain the water flow; and (3) entrances and exits to guide fish into and from the collection system. The operating agencies are responsible for maintenance of the tishways and for their operation within the designated criteria.

Fish facility operations at most of the projects are closely monitored and inspected by project operators and biologists at all COE and PUD dams. State and federal fishery agency personnel continue to make monthly inspections of adult passage facilities to assure that operations continue within accepted fishway criteria. The Fish Passage Center coordinated fish facility problems and actions from the COE and PUD projects with State, Federal, and Tribal fishery agencies.

Specific operations and problem areas noted at adult fish passage facilities are listed by project for 1993. By no means is this list exhaustive; however, it does point to the complexity of operations and potential difficulties fish encountered at Columbia/Snake River dams.

Bonneville Dam

The project's normal operation throughout most of the adult salmon passage time frame is: operation of the old powerhouse; provide spill up to 75 kcfs (daytime); and then bring the new powerhouse on line. During the evening hours, about 200 kcfs spill volume was allowed to improve juvenile fish passage at the project. This change in spill/powerhouse operation on a daily basis undoubtedly affects adult fish passage at the project. With the old powerhouse prioritized for operation, more fallback of adult fish will occur (based on radio tracking studies by NMFS and COE) than if both powerhouses were operated at an equal rate or the new Powerhouse was prioritized.

Throughout the adult passage period, a new spill schedule developed for passage of juvenile fish was used. This spill schedule was based on model studies at the COE's hydraulic laboratory located in Vicksburg, Mississippi, and initiated after field observations were made at Bonneville Dam. This same spill schedule was used for adult fish passage also. Fish counts at the viewing window located at the Upstream Migrant Transport channel indicated that adult chinook were entering the Cascades Island fishway (spillway entrance) under daytime spill conditions (75 kcfs), using the new spill pattern. It is not known whether these numbers were increased or decreased from previous years, when a different spill pattern was used for adult fish passage. When the video tapes are read, it might be possible to assess adult fish passage through the Cascades Island fish fishway. Higher levels of daytime spill were required during May and June when flow increased. During most occasions, adult fish still were able to locate the spillway entrance with the new spill schedule in place.

Overall, the Bonneville flshways operated close to criteria throughout the fish passage season. No reports of long-term failure were noted regarding the two fish turbines at the new powerhouse nor the auxiliary water supply valves to the remaining fishways at the old powerhouse. In late November and early December, the fish turbines at Powerhouse II were taken out of service for repair (Fl) and due to build up of trash in front of the turbines (F2). During this period, the ice and trash sluiceway provided auxiliary water flow, which was about half the normal flow to the fishway supplied by the two fish turbines, Minor adjustments are generally made whenever fishways problems are noted by COE or fishery agency personnel. These include debris related problems on trashracks, picketed leads at the counting station, or other points in the ladder or fishway. During the 1993 season, high debris loads were common throughout the spring and early summer months. In addition, grasses and other materials were present during the late summer and fall seasons and resulted in some parts of the fishway being out of criteria for short time periods.

The Dalles Dam

Adult fishways at The Dalles Dam are controlled by flow from two small fish turbines. When these operate satisfactorily, over 5,000 cfs of water are supplied through diffusers to the fishway entrances, as well as along the powerhouse collection channel. It is especially critical to have both turbines operating during days when spill occurs. Prior to the 1993 season, several diffusers located in the south spillway entrance were repaired to increase flow from that entrance. The COE fishery field unit adjusted diffuser settings throughout the junction pool area and through the powerhouse collection channel for the purpose of improving velocity and flow conditions prior to the spring chinook migration at the project. This effort definitely improved velocities throughout the fishway, and appeared to move water to the major fishway entrances so that the project was within criteria in regard to head differentials, weir depths, and most other parameters checked.

A change in operation of the north fishway and adjacent spillbay were tested during the adult migration season. About 1,500 cfs of water was spilled from Bay #l to attract fish more quickly and to potentially increase the proportion of fish passing the north shore fishway. When Fish Turbine #l failed late in the fall of 1993, spill from Bay #l was used to provide additional attraction to the north shore while the other fishway was operating at a lesser criteria. The COE fishery research unit is currently evaluating whether this operation significantly improved fish passage over the normal operation at the north shore fishway.

In late September. an oil slick was observed in the Oregon shore fishway by the COE fisheries field unit. The fish turbine was later shut down, and when adult fish were noted in the auxiliary water supply, the south fishway was dewatered and diffuser gratings were inspected in the entrance area. Diffiser gratings in the south fishway entrances were repaired; however, the entrance was not put back in service, since the COE was unable to repair the fish turbine prior to the new year. In addition to the south shore entrance diffuser grating problems, it was also discovered that diffuser gratings were displaced from their normal location in the upper section of the junction pool of the Oregon fishway. These diffusers were closed to preclude any fish from entering the auxiliary water supply. Some fish were salvaged from the south fishway entrance, channel, and auxiliary water supply, but nearly 60 adult steelhead were noted dead in The Dalles fishways. During the winter maintenance period, a portion of the east fishway was dewatered. Several diffuser gratings were displaced and both live and dead fish were observed below the gratings. About 240 fish were reported dead and an additional fish salvaged live from this area. In total, greater than 300 adult fish were killed due to equipment failures at The Dalles Dam in 1993.

Operational changes were made on the diffuser settings during the 1993 season. Displacement of diffuser gratings from their slots may have been caused from these changes. To assure that this does not occur in future years will require that diffuser gratings and associated equipment be frequently examined and modified (at least annually) if required, to assure that these diffuser gratings can not be displaced and fail. Displacement of diffuser gratings can result in unacceptable adult fish mortalities.

We have been unable to determine why the repair of the fish turbine unit took so long, since normal packing and maintenance of a unit generally takes about two weeks. Impacts to fish passing The Dalles project were evident this season, and the COE should make every effort to improve passage conditions prior to the 1994 season,

John Day Dam

The Oregon shore fishway was operated at or near established criteria. Generally, head differentials and weir depths at the main entrances were within criteria ranges. Adult fish were trapped at this location for the adult radio telemetry study conducted in 1993. This may have caused some level of delay below the trapping facility that cannot be quantified. The modifications that were completed in the upper section of the fish ladder appear to have improved passage conditions somewhat, *i.e.*, fewer fish (mainly steelhead) were noted jumping than were observed in prior years, although several still jumped from the ladder and subsequently perished. Also, fewer fish were observed holding in the transition pools, but delays were still evident both visually and as confirmed by the radio telemetry studies, Further work must be completed on this section of the Oregon fish ladder to reduce delays of fish passing this ladder.

The north shore fishway has six pumps that can supply water through the auxiliary water conduit system. At present. only three of the six pumps can operate at any one time. At least one spare pump is available for use if any one of the three fails. The amount of flow that can be supplied to the entrances through the present conduit and diffusion system is insufficient because of poor hydraulic conditions in the supply pipe. This problem was referred to the COE's hydraulic design branch for evaluation. Until the system has been evaluated and eventually changed, reduced water flow will be available for the north shore fishway.

Another minor problem that exists in the late fall is the upstream, downstream movement of the adult fish at the Washington shore counting station. This delay has been observed in past years.

McNary Dam

During 1993, the adult fishways were operated within or near criteria during inspections conducted by fishery agency personnel. Only very brief pump outages (generally less than two hour duration) occurred and they were coordinated such that any work requiring an outage was completed during the afternoon, Passage of adult fish at the McNary project appeared to be satisfactory this season.

During the late fall, fishway operation was placed on manual rather than automatic control for the purpose of pulling and re-wiring the fishway. This resulted in some short term out-of-criteria conditions. The project will have an automated fishway control system prior to next year's fish migration season.

Priest Rapids Dam

Throughout the past years and continuing in 1993, passage of adult fish and their subsequent arrival at upstream projects has been a concern at this project. As an example, the spring chinook count at Priest Rapids was near 29,000 fish, plus an additional 4,000 were hauled above the dam from Priest Rapids Hatchery for a total of 33,000. The count of adult spring chinook at Rock Island Dam was near 20,000 fish. This leaves 13,000 fish unaccounted for between Priest Rapids and Rock Island dams. It is known that some portion of the fish will fallback over the spill or possibly through the turbine units and lead to an overcount at Priest Rapids, but this high differential count still leaves reason for concern.

During the 1992-93 winter maintenance period, new valves and operators were placed in the collection channel. However, when the new valves were installed, no note was made of the position of the valve when placed in the valve vault. During the initial inspections in April, the electric power to the diffuser valve operators was not hooked up and changes to the system were not fine-tuned, which led to out of criteria conditions for some time. In addition to this, the fishway automation was not completed as anticipated; a contractor defaulted on his contract and this essentially put off automating the system for at least a year. Completion of spillbay modifications was behind schedule and that affected spill patterns when spill occurred this season. These repairs affected the gate under repair plus the adjacent gate on either side. Grant County PUD anticipated that a hydraulic evaluation of the fishway would be completed prior to the 1993 adult migration season. It also was not completed.

On almost every occasion when the fishways were inspected, the head differentials measured at the main entrances on the left bank fishway were less than minimum criteria (criteria = 1.0 to 2.0 feet). There was one positive point, turbine units 1 and 10 were not operating during most of the inspections, and this allowed the flows to reach out further into the tailwater. The main entrances are located adjacent to either Unit 1 or 10. A continuing problem noted during the inspections has been the lack of proper channel velocity (criteria = 1.5 to 4.0 fps) in the collection channel, mainly from the junction pool area to Units 1 and 2. From there, velocities generally are considered satisfactory. On average, velocities (surface estimates) reported by the inspectors were less than 1 .O foot per second (fps). During the initial inspection. one side of the channel had some reverse surface flow. Grant County PUD was informed of all discrepancies. met with the fishery agencies and tribal representatives on several occasions, and attempted to improve the situation within the constraints of their present fish facilities and present auxiliary water supply system.

Overall, the fishways at Priest Rapids remain a cause for concern. and a hydraulic evaluation of the fishway is required to improve flows through the collection channel. The system requires automation of the control system for the main entrance gates, floating gates, pump flow, etc. The auxiliary supply system should be capable of adding enough water to adequately meet entrance (head differential and weir depths) and flow requirement along the collection channel. In future years, Priest Rapids fish counting facilities should be upgraded to a more modern one that would also allow counting by video camera. At times, a trapping facility was operated near the exit of the left bank fish ladder, and this will cause some level of delay for fish passing that ladder.

Wanapum Dam

The fish facilities at Wanapum Dam appeared to operate satisfactorily for the season. Generally, the weir depths, head differentials, channel velocities and other check points were found operating near criteria. During periods of daytime spill, the spill pattern was affected by continued repair of the spillbay gates by contractors. Up to three gates were affected, i.e. the gate under repair plus the adjacent gate on either side. No fish counting facilities are in use at Wanapum Dam so passage counts and other recent information on fish passage are not available for comparison to the Priest Rapids and Rock Island Dam counts. The auxiliary water supply equipment worked satisfactorily this season, with no long term pump outages or other fishway related problems.

Fishways will be upgraded in the near future and will include computerized automation of controls, hydraulic evaluation of the fishway, etc. These improvements will improve operation of the Wanapum adult fish facilities.

Rock Island Dam

Passage conditions should have been satisfactory during most of the fish migration season. The project removed the fiberglass panels in the new powerhouse transportation channels. and replaced them with a more permanent concrete wall (panel) during the winter maintenance period. This modification worked satisfactorily and was not subject to problems that were evident with the fiberglass panel walls. Channel velocities through the transportation channels are normally in the upper end of the velocities recommended for satisfactory fish passage.

The right bank fish counting station has been a real cause of concern regarding delay of fish passing the counting station.

The radio telemetry study conducted in the mid-Columbia by NMFS should answer the question of time required for fish to pass the right bank fish ladder. Based on those results (if they should delay), modifications to the right bank counting station should be planned for and designed to ultimately improve passage conditions at the right bank ladder.

Rocky Reach Dam

The project has only one fish ladder for adult fish passage with the spillway collection channel converging to join the powerhouse collection system. In past years, one of the main concerns at the project has been the operation of Turbine Unit 11 during daylight hours. Possibly the adult passage study using radio telemetry tags will confirm whether this operation is detrimental to fish passage. As well, it will be the first real look at each of the entrances for fish preference and should assist managers in deciding how the fish passage facilities might be improved. The fish trap located near the exit of the ladder was used to capture fish for supplementing, i.e. marking additional fish for the radio telemetry work. When this operates, fish cannot pass directly through the counting facility without delay.

Overall, it is not known how well fish passed the project, but all pumps and associated fish passage equipment were operated satisfactorily with few hours of downtime throughout the season.

Wells Dam

The project has two main fishway entrances that essentially joins the downstream end of the fish ladder at each end of the dam. The fishways have no powerhouse collection or transportation channels, but use high velocity water jets that are designed to attract fish from the powerhouse tailrace. Again, it is not known how weil this system works for attracting fish without reviewing study results from the radio telemetry work.

It was discovered in late April that a side diffuser panel was dislodged from its bracket, and this resulted in Douglas County PUD taking the east fishway out of service until the auxiliary water supply and diffusion system was repaired. The fishway was operated with one pump for at least five days. This incident might have been averted if annual maintenance was completed on the fishway. Maintenance had not been completed on that section of the fishway since 1990. Fortunately, few adult salmon were present in the mid-Columbia when this ladder outage occurred,

The fish facilities operated satisfactorily during the remainder of the season in regard to fish pumps, equipment, etc. The inspections revealed that the project was within or near criteria in regard to the main entrance and ladder conditions. Trapping of adult salmon and steelhead for brood stock occurred at different times throughout the year. Also sockeye were sampled one or two days per week for age determination. Any trapping activity will result in some delay of fish passing that project,

Ice Harbor Dam

The south shore fishway at Ice Harbor operated near accepted criteria during the 1993 season, The project has a computerized automated control system that worked satisfactorily during most of the past two seasons: although it would have been beneficial to review parameters with the COE to assure the fishway flows were balanced during periods of high river flow. The north shore operated with two fish pumps from July through mid-November. During this time frame, the tailwater was low and the weir was generally on-sill, so two pumps were able to keep the north shore entrance near acceptable criteria.

An adult fish trap located in the south fish ladder was operated periodically throughout the fall season to capture and tag adult salmonids as part of the adult fish studies being conducted in the Snake River. Whenever trapping occurred, there was some degree of fish delay in the ladder.

Lower Monumental Dam

The fishways were generally operated close to accepted criteria during most of the fish migration season, although we noted on several inspections that the main entrances had less head differential than required (criterion = 1 .O to 2.0 feet), and on one occasion found the weir depth well below the accepted level. The fish facilities now incorporate excess flow from the juvenile bypass system, and that allowed the project to operate the fishway with higher flows than during previous seasons.

Overall, fish passage at Lower Monumental Dam was satisfactory with the exception of the high spill period, when few fish moved through the Snake River. In terms of equipment, the turbine pumps operated satisfactory with little or no recorded downtime. Two of the fish pumps will be worked on this 1993-94 winter, which should improve the performance of the pumps in future years. The remaining pump will be revitalized the following year.

Little Goose Dam

During 1993, the fishways were close to, but generally below, acceptable criteria in regard to head differentials and weir depths at the north powerhouse and shore entrances. The south shore flow was always within criteria. Operation of the spill bays at the project was affected by research operations and also by a malfunctioning spill bay. During the high spill period, the project was unable to operate all eight spill bays, and that resulted in using less bays to spill the excess water. This increased the dissolved gas levels below the Little Goose project. In addition, main fishway entrances were affected (due to high spill levels) and that resulted in poor adult passage conditions when spill was present.

In past years. the project has not always met minimum gate depth standards or head differentials at the north powerhouse and shore entrances. The three fish turbine pumps will be overhauled (new turbine runners) during the next two years, and that should increase pump flow. In addition, excess flow from the juvenile bypass system will be added to the auxiliary water supply, and potentially the project should meet minimum standards 95-100% of the time in 1994 and beyond.

Lower Granite Dam

At Lower Granite Dam, the fish facilities provided fair passage throughout most of the fish passage season. The spillway entrance at the north powerhouse was operated throughout the summer months in combination with one of the main north powerhouse entrances. Managers may be able to assess which north powerhouses entrances should be used based on radio telemetry data. It is well documented that delays to fish passage occur when the adult trap is operating; generally it was operated on a 24-hour per day schedule. Lower Granite fish facilities will also have computerized automated control installed prior to the 1994 fish passage season.

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APPENDIX A:

1993 Water Budget Coordinated Plan of Operation

CENPD-PE-WM (RCC)
March 9, 1993
DRAFT No.1
DRAFT No.2

COORDINATED PLAN OF OPERATION
FOR 1993 *WATER* BUDGET, RESERVOIR OPERATIONS
FOR FISH OUTMIGRATION, **AND** SNAKE RIVER
SUMMER/FALL FLOW AUGMENTATION

1. Introduction

This Coordinated Plan *of* Operation (CPO) outlines the procedure for implementing flow augmentation and special reservoir operations measures during the 1993 outmigration of juvenile salmonids. It covers the use of Supplemental Water and Water Budget volumes in the Columbia and Snake Rivers, and the operations of the Corps' lower Snake River and John Day Reservoirs. The CPO has been developed by the U.S. Army corps of Engineers in cooperation with the Northwest Power Planning council (NPPC), Fish Passage Center (FPC), fishery agencies, Indian tribes, Bonneville Power Administration (BPA), U.S. Bureau of Reclamation (USBR), utility companies, and others. Water Budget implementation periods are April 15 through June 15, 1993 for the Lower Snake River projects; and May 1 through June 30, 1993 for the Columbia River projects.

Measures provided in this CPO are consistent with Amendments to the Northwest Power Planning Council's Fish and Wildlife Program (Phase Three) adopted in November 1992, the National Marine Fisheries Service's Biological Opinion for 1993 operations, and the Corps' Supplemental Environmental Impact Statement (Interim Columbia and Snake Rivers Flow Improvement Measures for Salmon). These measures address the objectives of helping all weak stocks, especially naturally produced stocks and those that are threatened and andangered.

The Snake River summer/fall flow component of the 1993 operation is also included in this document. Implementation period for this component is June 16 - September 30, 1993.

2. Water Supply Forecasts

A copy of the interagency coordinated April 1, 1993 Water Supply Forecasts issued by the National Weather Service's Northwest River Forecast Center is attached as Enclosure 1. These forecasts are based on April 1 hydrologic conditions and median precipitation from April through the end of July 1993. Summary forecasts for key Columbia and Snake River locations are given in Table 1, in thousands of acre-feet (Kaf) and percent of normal for the 1961-90 period (%). Corresponding percent values for 1992, with reference to the same 1961-90 period, are also given for comparison purposes.

Table 1. Forecast Summary
(March mid-month. Will be updated)

	<------------ Period			------------>		
	Jan-Jul			Apr-Jul		
	... 1993 ...		'92	... 1993 ...		'92
Location	(KAF)	(%)	(%)	(KAF)	(%)	(%)
Grand Coulee	46,400	73	(71)	40,000	73	(76)
Rock Island (*)	50,900	74	(79)	43,900	73	(76)
Brownlee	5,450	56	(40)	3,220	56	(31)
Dworshak	2,510	71	(67)	1,910	71	(59)
Lower Granite	21,500	72	(51)	15,700	73	(46)
The Dalles	76,800	73	(67)	61,400	74	(64)

(*) For use in estimating Priest Rapids forecasts

3. Reservoir Status

The reservoir system, in terms of Mw-months, is xxx percent full compared to 42 percent full in April 1992. Most reservoirs are at or below flood control rule curves, and well above operating rule curves. Table 2 summarizes the status of major reservoirs as of March 22, 1993. Elevations for the same date in 1992 are shown between brackets.

Table 2. Reservoir Elevations

Reservoirs	Max/Min Limits (Msl)	Max Capacity (Maf)	... Elevation . . 1993 (Msl)	(1992)
Mica	2470/2394	7.0	2345	(2406)
			*	(2430)
Arrow	1444/1378	7.1	1389	(1417)
Duncan	1892/1794	1.4	1799	(1820)
Libby	2459/2287	5.0	2323	(2363)
Hungry Horse	356013336	3.2	3373	(3483)
Albeni Falls	2062/2050	1.2	2051	(2053)
Grand Couiee	1290/1208	5.2	1257	(1288)
Dworshak	1600/1445	2.0	1554	(1556)
Brownlee	2077/1976	1.0	2072	(2075)

* adjusted elevation

As of April 1 there are over five million acre-feet (Maf) of Water above the normal operating rule curve for power generation and fish flow augmentation. However, by May 1, this value is expected to be close to three Maf. If Grand Coulee and/or other project(s) holding a wortion of the three Maf are near their flood control requirement and an earlv spring run-off occurs, the amount of water that can be held bacK will-be limited *Under* these conditions, there would be limited opportunities for shaping flows to a lower level for fish during the springq outmigration. Even though the shaping ability may Se different than previous years, the higher than normal reservoir levels will allow more of the natural run-off to go downstream during the juvenile migration period.

On the other hand, there should be little or no flow shaping problem during normal or late run-off conditions because the available fish storage in Grand Coulee can be used to augment lower flows during the early part of May, if necessary.

4. Data Exchanqe

a. The FPC shall be represented at the daily Reservoir Control Center (RCC) briefings. The FPC will prepare and deliver a fisheries report for each Thursday briefing from April 15 through June 30.

b. The Corps and BPA shall make available to the FPC and the NPPC's Water Budget Advisor the forecasts prepared for system planning purposes, including flow projections without fish flow augmentation, if applicable.

5. Flow Aucnnentation

The FPC will shape flow augmentation based upon the projected flows and the actual migration with the general objective of utilizing flow augmentation to mitigate the effect of decreasing flows on downstream passage. The constraints placed on use of the volume by other system requirements will limit the ability to shape flows. The FPC will include available information regarding the composition of the migration at the time a reguest is made.

Flow augmentation requests are based on historical and real-time data including mark recaptures, passage indices, fish condition, flow forecasts, flows, dissolved gas saturation, water temperature, spill, and hatchery release information. Flow augmentation Strategies coupled with base flows and migration monitoring is aimed at providing favorable migration flow for *all* components of the migration recognizing the volume and system limitations. Particular attention will be paid to migration of Endangered Species Act (ESA) listed stocks.

6. Columbia River Flow Augmentation for Fish

a. The volume of water stored for Columbia River Flow Augmentation by April 30 is made up of two parts. The first part consists of the 3.45 Maf Volume which is presently included in Pacific Northwest Coordination Agreement (PNCA) firm planning. The second part represents an additional auqmentation volume of Up to 3.0 Maf determined according to the NPPC's procedure shown in Enclosure 2. This additional augmentation volume is operationally stored in Grand Coulee and other reservoirs.

b. The 3.45 Maf portion included *in* PNCA firm planning is incorporated in the Ooeratina Rule curves (ORC). The Augmentation Volume is not included in the ORC and, therefore, is stored above the ORC but below the flood control rule curve.

c. On April 30, a comparison of the composite Libby and Grand Coulee actual storage content to the composite ORC content at these *two* projects will be made in order to establish the quantity of water stored in excess of the Augmentation Volume for fish. This excess quantity (but no more) may remain above ORC on June 30 (see Enclosure 3).

d. Based on the above conditions, the January - July 1993 water supply forecast, and Dworshak releasing about 1.0 Maf over a minimum outflow of 1.2 Kcfs, the average flow at The Dalles between May 1 and June 30 is expected to be about xxxx Kcfs. Changes in the current forecast could, however, modify that expected flow level.

e. Beginning on April 29 and continuing weekly through June, a weekly average flow target at The Dalles will be established for the following week. This will be accomplished by projecting an average regulated flow at The Dalles for the period of the current week through June 30 (see Enclosure 4). The projected period flow is that which results from operating the *reservoirs to* ORC (plus excess quantity, if any) by June 30 while maintaining flood control space.

f. Run-off and flood control requirements in May and early June may force flows at The Dalles to be greater than the average flow projected for the remainder of the period as defined in paragraph 6.e. At times when the flows are required to be greater than the average flow projected for the remainder of the period and an excess quantity (as described in paragraph 6.c) of water exists, the excess cuantitv will be reduced each week by the difference between the-required flow and the weekly average flow target 'described in paragraph 6.e).

g. Average weekly (Monday through Sunday) flow target (defined in paragraph 6.e) at The Dalles will be made available to the FPC by 2:30 P.M. on Wednesday of the preceding week. The FPC will notify the RCC by noon on Thursday of the preceding week that they accept the projected flows, or would like to *reauest* another flow level that would be provided from the water available for flow augmentation for fish. The requested flow target will be deemed as met as long as the observed weekly average is within 2.5% of the flow target.

h. Flow orojecrions made above are only available as a result of anticipated svstem and water supply conditions in 1993. Since these factors change from year to year, a 1993-type operation may not be possible in *future* years. The shift of flood control space from Dworshak to Grand Couiee may aiso reduce the ability to store water for Columbia River fish flow augmentation.

1. The RCC and FPC will jointly monitor the actual run-off and juvenile migration conditions and may, by mutual agreement and after consultation with other affected parties in the Fish Operations Executive Committee (FOEC), modify the -Columbia River Flow Augmentation for Fish operation.

7. Snake River Flow Augmentation for Fish

a. Requests from the FPC for Snake River Flow Augmentation for Fish will be met from uncontrolled run-off and releases from Dworshak (DWR) and Brownlee (BRN) Reservoirs.

b. When BPA has an active account with Idaho Power Company (IPC), requests to augment flows for fish will be met with releases from either or both DWR and BRN. Water Budget release from DWR will be done in accordance with provisions outlined below. Water Budget release from BRN will be done in accordance with applicable IPC/BPA Contract.

c. The Water Budget quantity for BRN will be identified by IPC on April 15, with subsequent updates. If BPA has stored water in BRN, the quantity will be identified by BPA on April 15, with subsequent updates. Based on current forecast, the Water Budget for BRN is expected to be about 110 Kaf.

For the April 15 - June 15 period, the USBR and BPA will arrange to release up to 190 Kaf from USBR projects and upper Snake River water banks that can be made available for water rental. This release is dependent upon availability of water surplus to irrigation demands. IPC will report *on* its ability to shape this water by April 15. This volume of water does not increase the average regulated flows at Lower Granite Dam between April 16 - June 15 as Brownlee is drafted and then refilled within the same period.

System flood control requirements for Brownlee, if available, may be transferred to Grand Coulee,

d. The volume of water from DWR that can be used consists of two parts: Supplemental Water and Water Budget. The Supplemental Water is the volume of water that results from a temporary shift of system flood control space requirement from DWR to Grand Coulee Reservoir. The Water Budget is a fixed volume of water that varies with the run-off forecast.

e. The Supplemental Water is determined based on the difference between the DWR April 15, 1993 elevation and the DWR system flood control requirement on the same date. Based on the current water supply forecast and projected operation, the supplemental water available in 1993 is xxxx Kaf.

f. The current April-July water supply forecast at Lower Granite (LWG) is less than 16 Maf. Therefore, the 1993 Water Budget volume will be 1,000 Kaf. Usage period for the Water Budget is April 15 through June 15.

g. The Water Budget volume of 1,000 Kaf from April 15 - June 15, will be debited daily by the amount DWR release exceeds the minimum flow of 1.2 Kcfs.

h. Because of normal minimum flow requirement and safe channel capacity limitation, release from DWR should be no less than 1.2 Kcfs and *no* greater than 25 Kcfs.

1. Based on the above conditions and the current January-July 1993 water supply forecast at LWG, the average flow at LWG from April 15 through June 15 is expected to be about XXX Kcfs.

J. Beginning the week prior to April 15 and continuing weekly through June 15 every weekday the RCC will provide, if available, the FPC with (1) a 5-day forecast for the Snake River flow at LWG prepared by the NOAA River Forecast Center, (2) a 5-day operational forecast prepared by IPC for releases at BRN, and (3) a 5-day operational forecast prepared by the Corps for releases at DWR.

k. The FPC, utilizing the information received and other relevant data, shall make flow augmentation requests to the RCC no less than 72 hours in advance of the expected implementation to allow BPA and IPC to schedule flows. Requests will be made Monday through Friday (except holidays) verbally to the RCC and followed by written confirmation. No requests for flows or modifications will be acted upon between Friday 10:00 a.m. and Monday 8:00 a.m.

1. The RCC and FPC will jointly monitor the run-off and juvenile migration and may, by mutual agreement and in consultation with other affected parties in the FOEC, modify the Snake River Flow Augmentation for Fish operation.

8. Lower Columbia River Weekend and Holidav Flows

Attempts will be made to provide weekend flows at the lower Columbia River projects at least equal to 80 percent of the average flow for the previous five weekdays during the period May 1 through June 30. Memorial Day weekend will be treated the same way.

9. Other Reservoir Operations

The following additional reservoir operations are scheduled during the outmigration of wild and natural salmonid stocks:

a. Operate Corps' lower Snake River reservoirs including Lower Granite, Little Goose, Lower Monumental and Ice Harbor near minimum pool (one foot operating range) between April 15 and July 31;

b. Maintain John Day Reservoir forebay between Elevation 262.5 and 264.0 between about May 1 and July 1. From about July 1 through August. 30, operate John Day Reservoir above Elevation 265 as needed to meet irrigation requirements;

C. Fluctuate releases from Dworshak Reservoir between 1 and 15 Rcfs between mid-June anti early July if requested by the FPC and providing there is no net weekly draft of storage from Dworshak;

d. kdjust instantaneous outflows from Lower Granite Reservoir as needed to provide the most efficient release pattern for fish movement past Lower Granite Cam, without changing the daily release volume; and

e. Reservoir operations listed in this section will be closely coordinated with BPA, FPC and all other parties concerned.

10. <u>Snake River Summer/Fall Flow Aucnnentation</u>

a. The total summer/fall flow augmentation volume from Dworshak Reservoir will be 470 Kaf above the minimum project outflow of 1.2 Kcfs. This volume is to be used during June 16 through September 30 as outlined below to maximize benefits to juvenile and adult fall chinook. Actual release of that water depends on fish migration, runoff, water temperature, and other conditions. The FPC should inform the Corps of its planned seasonal usage of the 470 Kaf volume as far in advance as is practicable, so that other water users can be notified accordingly.

In July, the USBR, BPA and IPC will arrange for the release of up to 137 Xaf from Brownlee Reservoir above the planned project outflow. This release is dependent upon the replacement from uncontracted storage within USBR projects and surplus irrigation water made available for flow augmentation from Idaho water banks.

Between September 1 - 30, BPA and USBR will arrange for the release of up to 100 Kaf from the upper Snake for temperature control. This release may be dependent upon availability of surplus irrigation water in the upper Snake River basin.

Also, for the September 1 - 30 period, up to 100 Kaf from Brownlee Reservoir will be released by IPC for temperature control.

b. Requests for releases from Dworshak and Brownlee will be made by the FPC with the goal to maximize benefits for fall chinook. Particular attention should be paid to providing flows for juvenile fall chinook that are actively migrating in the Lower Granite reservoir. The Fish Passage Center shall make flow augmentation requests to the Reservoir Control Center. IPC requests at least 72 hours notice to schedule flows and notify the river users about changes from Brownlee. BPA requires at least 48 hours advance notice to schedule results of flow changes at Dworshak.

Requests will be made Monday through Friday (except holidays) verbally to the RCC and followed by written confirmation. No requests for flows or modifications will be acted upon between Friday 10:OO a.m. and Monday 8:00 a.m.

C. Temperature of water being released from Dworshak can be reduced to approximately 45 degrees F during periods when portions of the 470 kaf are being released. Determination of Dworshak outflow temperatures will be made jointly by me agencies and tribes, and provlaed to the RCC through the Fish Passage Center. When the Dworshak outflow is below 2 Kcfs, the nater temperature should be adjusted to meet U.S. Fish and Wildlife Service's preference.

d. Dworshak outflow will not exceed 25 kcfs.

e. Use of water from Dworshak and Upper Snake River as discussed earlier is only feasible as a result of anticipated system and water supply conditions in 1993. Since these factors change fr a 1993-type operation may not be possible in future years.

f. The RCC and FPC will jointly monitor the actual runoff and juvenile migration conditions and may, by mutual agreement and after consultation with other affected parties in the Fish Operations Executive Committee and NMFS, modify the Snake River Summer Flow Augmentation for fish operation.

9. Hatchery Coordination. All requests for water cooler than 55 degrees F should be coordinated with the Dworshak National Fish Hatchery as far in advance of the desired implementation data as possible in order to minimize adverse impacts on the hatchery fish.

h. Water Temperature Studies and In-season Monitoring. The Corps will assist the FPC and other agencies in performing selected water temperature model studies to formulate summer flow augmentation plans. The Corps, in cooperation with other agencies, will also continue to monitor water temperature below Dworshak and Brownlee Reservoirs during the summer flow augmentation period.

11. Nonimplementable Water Budget/Flow Augmentation Request

A Water Budget or summer/fall flow augmentation request may not be implemented if it conflicts with other project requirements (e.g. accidental spillage of toxic materials, loading and unloading of special cargos, emergency repairs at bridges and other facilities, FCC.). The severity of the conflict will be analyzed by the Corps in consultation with other project owners. Appropriate action will be taken with documentation of the basis for the decision'forwarded co the FPC, NPPC's Water Budget Advisor, and Fish Operations Executive Committee.

Appendix B:

1993 Smolt Monitoring Memos

FISH PASSAGE CENTER
2501 S.W. FIRST AVE. SUITE 230 PORTLAND, OR 97201-4752
PHONE (503) 230-4099 FAX (503) 230-7559

MEMORANDUM

FROM: Margaret Filardo (for) Michele DeHart, Fish Passage Manager

DATE: July 30. 1993

TO: Donna Darm. National Marine Fisheries Service

RE: Your Request for Passage Tiig Plots of ESU Stocks

Enclosed in both tabular and graphic formats are rhe timing values for ESU stocks of Snake River chinook and sockeye arriving at Lower Granite and McNary dams. The data have been summarized to indicate the minimum and maximum calendar dates of detection, as well as the absolute range of dates encompassing 90% of the distributed passage. These summaries were derived from 1989-1992 PIT tag detection data. taken from the PTAGIS database, as well as PIT tag detections during the current year through July 27. derived from the FPC's own basin-wide PIT tag database. PIT tag data provide the only source for stock-specific analyses of passage timing. For the purpose of this comparison. we have assumed that the marked fish in these groups were representative of their respective populations-at-large, at least with respect to their migration behavior. However. caution must be exercised in utilizing these data in timing analyses. as this may not have been an objective of the researcher at the time of taggmg. The indivudual tagging and observation records used for this summary are the best data currently available. but are subject to revision if and when the raw data input is updated.

Seven groups of chinook are represented in the summar ies. Two of those groups, the Imnaha spring chinook and the Snake fall chinook. are comprised of single release groups. The other five groups are comprised of multipie groups released within defined geographic areas. These groupings are as follows.

Lower Grande Ronde	releases in Lostine. Minum.Wenaha. and West fork Wenaha rivers.
Upper Grande Ronde	releases in Grande Ronde River and Catherine Creek.
South Fork Salmon	releases in South Fork Salmon and Secesh rivers. Lake and Johnson creeks
Middle Salmon	releases in Bear Valley, Big, Camas. Cape Horn. Chamberlain. Elk. Loon. Marsh. Rush. and Sulphur creeks. and Lemhi River
Uouer Salmon	releases in Alturas Lake Creek. Redfish Lake Creek. Pettit Lake Creek. Beaver. Fourth of July. Frenchman. Herd. Huckleberry, Pole. Smiley, and Valley creeks. Pahsimeroi. Salmon. and East Fork Salmon rivers. and at the Sawtooth Trap

Not all release sites are represented in all years. No chinook were PIT tagged in the Lower Grande Ronde or middle Salmon reaches for the 1989 migration year. Similarly, Snake River fall chinook were first PIT tagged in 1991.

Dates of **Wild** Chinook Passage at Lower Granite Dam
(from **PIT** Tag Data)

River Reach & Stock	Detection Year	Detection Dates				Number Detected
		Minimum	5%	95%	Maximum	
Imnaha River Summer Chinook	89	04/04	04/04	05/27	06/05	73
	90	04/05	04/09	05/12	05/27	161
	91	04/14	04/14	05/15	05/15	19
	92	04/06	04/08	06/03	06/08	94
	93	04/15	04/22	05/30	06/23	160
	Summary	04/04	04/04	06/03	06/23	507
Lower Grande Ronde Spring Chinook	90	04/30	04/30	05/31	05/31	8
	91	04/20	04/24	06/04	07/09	90
	92	04/12	04/14	05/21	06/02	92
	93	04/14	04/18	05/18	06/03	310
	Summary	04/12	04/14	06/04	07/09	500
Upper Grande Ronde Spring Chinook	89	04/27	05/09	06/23	07/22	242
	90	04/16	04/16	04/23	04/23	2
	91	04/17	04/26	06/12	06/23	77
	92	04/09	04/15	05/28	06/29	67
	93	04/23	04/30	06/16	06/26	190
	Summary	04/09	04/15	06/23	07/22	578
Lower Snake River Fall Chinook	91	06/14	07/13	08/28	09/05	42
	92	05/04	06/03	07/03	07/21	43
	93	05/28	06/14	07/26	07/27	147
	Summary	05/04	06/03	08/28	09/05	249
South Fork Salmon Summer Chinook	89	04/09	04/16	06/19	07/19	275
	90	04/10	04/12	06/27	07/21	162
	91	04/13	04/18	06/27	07/20	177
	92	04/05	04/10	07/02	07/27	124
	93	04/21	04/22	07/03	07/15	313
	Summary	04/05	04/10	07/03	07/27	1051
Mid Salmon River Spring Chinook	90	04/09	04/15	07/06	07/18	584
	91	04/17	04/20	06/27	07/01	230
	92	04/05	04/06	06/24	07/13	466
	93	04/14	04/21	06/29	07/27	602
	Summary	04/05	04/06	07/06	07/27	1882
Upper Salmon River Spring Chinook	89	04/07	04/15	07/08	07/08	369
	90	04/11	04/14	06/14	06/28	89
	91	04/16	04/16	06/28	07/13	175
	92	04/07	04/10	07/20	07/20	202
	93	04/19	04/20	07/16	07/27	426
	Summary	04/07	04/10	07/20	07/27	1261

Dates of **Wild** Chinook Passage at **McNary** Dam
(from PIT **Tag** Data)

River Reach & Stock	Detection Year	Detection Dates Minimum	5%	95%	Maximum	Number Detected
Imnaha River Summer Chinook	89	04/21	04/23	05/24	05/31	30
	90	04/20	04/24	05/26	05/27	33
	91	05/06	05/06	05/22	05/22	5
	92	04/22	04/24	06/14	06/19	40
	93	05/03	05/04	06/15	07/13	43
	Summary	04/20	04/23	06/15	07/13	151
Lower Grande Ronde Spring Chinook	90	06/03	06/03	06/03	06/03	1
	91	05/07	05/07	06/21	06/21	19
	92	04/26	04/27	06/01	06/08	41
	93	05/03	05/04	06/07	06/15	102
	Summary	04/26	04/27	06/21	06/21	163
Upper Grande Ronde Spring Chinook	89	05/16	05/16	06/27	07/02	52
	91	05/11	05/11	06/15	06/15	7
	92	04/03	04/26	06/02	06/06	26
	93	05/10	05/11	06/25	07/01	73
	Summary	04/03	04/26	06/27	07/02	158
Lower Snake River Fall Chinook	91	08/10	08/10	09/06	09/06	4
	92	06/01	06/01	08/08	08/08	7
	93	05/08	05/08	07/10	07/10	5
	Summary	05/08	05/08	09/06	09/06	16
South Fork Salmon Summer Chinook	89	04/21	04/25	06/15	06/22	85
	90	04/26	04/26	06/07	06/13	34
	91	04/26	04/26	06/18	06/18	23
	92	04/18	04/18	07/16	07/16	16
	93	05/04	05/04	07/02	07/05	84
	Summary	04/18	04/18	07/16	07/16	242
Mid Salmon River Spring Chinook	90	04/26	04/27	06/19	07/07	92
	91	05/06	05/06	06/28	06/28	14
	92	04/23	04/23	07/18	07/18	104
	93	05/01	05/01	07/19	07/19	160
	Summary	04/23	04/23	07/19	07/19	370
Upper Salmon River Spring Chinook	89	04/22	04/26	08/09	08/09	122
	90	04/26	04/30	06/19	06/19	31
	91	04/19	04/22	07/04	07104	68
	92	04/24	04/24	07/16	07/16	51
	93	05/03	05/03	07/24	07/24	109
	Summary	04/19	04/22	08/09	08/09	381

Sockeye from the Stanley Basin have been PIT tagged and released into the Salmon River drainage since 1991. The detections of these fish at Lower Granite and McNary dams are summarized below. Note that this summary is based on a total of 32 fish detected between two sites over a three year period.

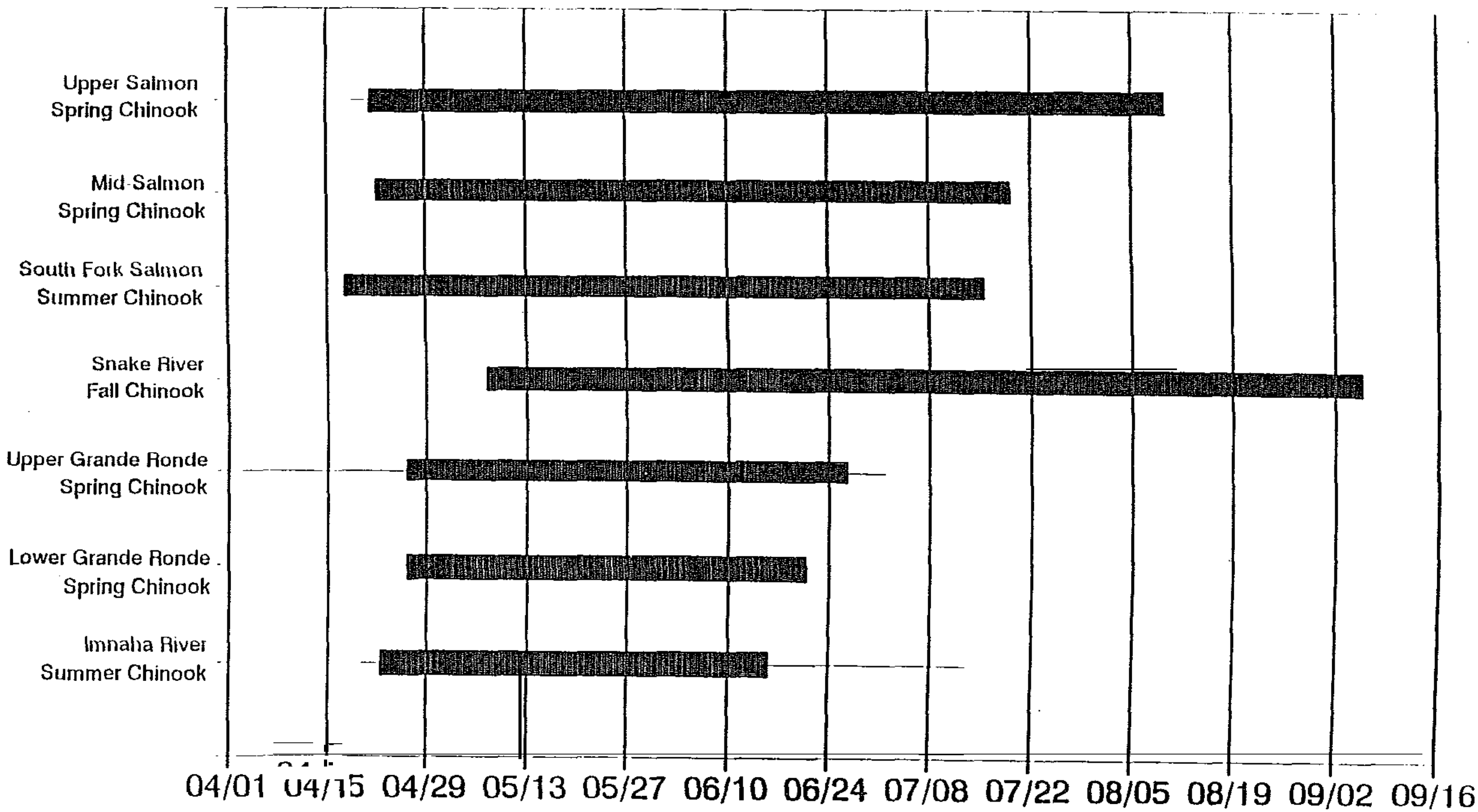
Dates of Snake River Sockeye Passage at Lower Granite and McNary Dams (from PIT Tag Data)

Detection Site	Detection Year	Detection Dates				Number Detected
		Minimum	5%	95%	Maximum	
Lower Granite	91	05/22	05/22	06/15	06/15	10
	92	05/08	05/08	07/19	07/19	11
	93	05/14	05/14	06/04	06/04	6
	Summary	05/08	05/08	07/19	07/19	27
McNary	92	05/18	05/18	06/10	06/10	2
	93	05/22	05/22	06/07	06/07	3
	Summary	05/18	05/18	06/10	06/10	5

I hope this information is useful to you. If you have any questions pertaining to these data, or a request for additional information, please don't hesitate to call.

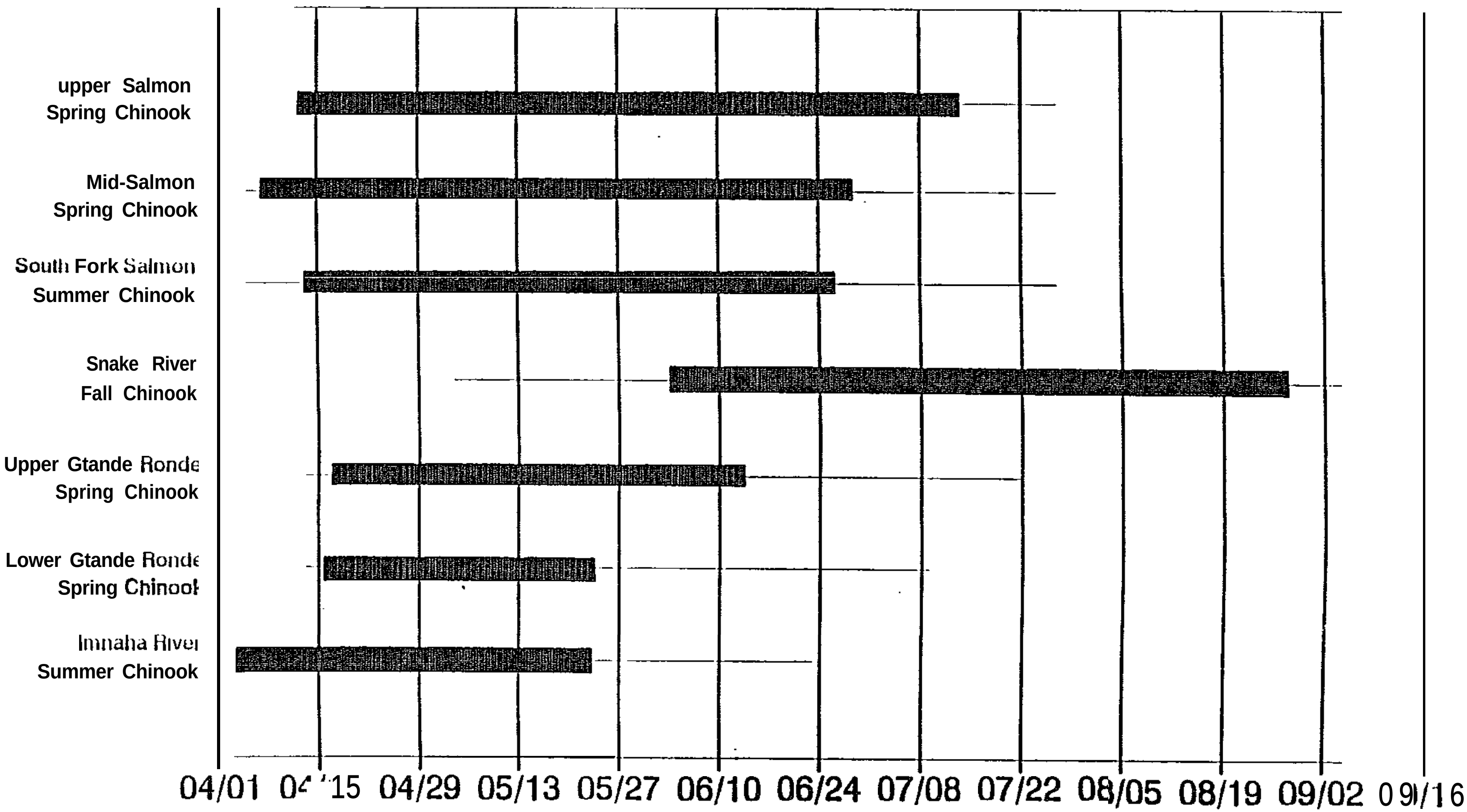
Dates of Wild Chinook Passage at MCN

Absolute Min, 5%, 95%, and Max Values



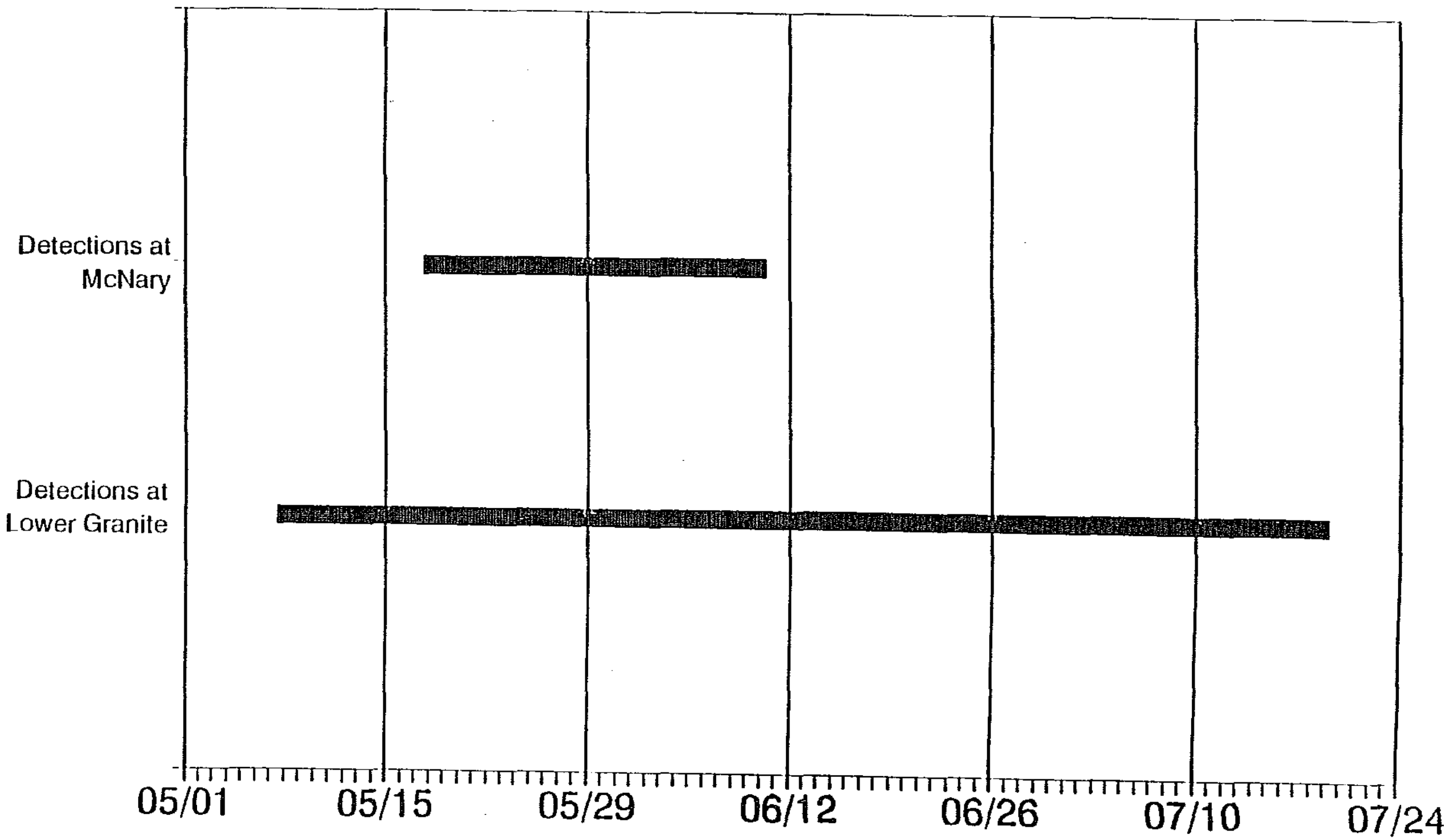
Dates of Wild Chinook Passage at LGR

Absolute Min, 5%, 95%, and Max Values



Dates of Wild SNK Sockeye Passage

Absolute Min, 5%, 95%, and Max Values



FISH PASSAGE CENTER
2501S.W. FIRST AVE. • SUITE 230* PORTLAND) , OR 97201-4752
PHONE (503) 230-4099 • FAX (503) 230-7559

MEMORANDUM

DATE: December 1. 1993

TO: Rob Lothrop, CRITFC
Earl Weber. CRITFC
Howard Schaller. ODFW
Charlie Petrosky, IDFG

FROM: Michele DeHart

RE: Analysis of the 1993 Snake River fall chinook PIT tag data

In response to your request for an updated Snake River fall chinook travel time/flow relation for use in the Agency/Tribal Life Cycle Model. I asked Tom Berggren of the FPC staff to analyze the 1993 USFWS Snake River fall chinook PIT tag data along with the data from the previous two years. Early in the analysis. ir was apparent that the 1993 data encompassed a much wider segment of the fall chinook popularion. Detection rates were much higher across all sizes of fall chinook PIT tagged in 1993. Smaller fall chinook (< 85 mm at time of tagging), which tend to migrate later in the season. were collected well into August and September in 1993 compared to very few collections of fall chinook during these months in the previous two years. It was apparenr that the 1991 and 1992 fall chinook migrations were n-uncared. thus giving the appearance of faster migration rates in 1991 and 1992 than occurred in 1993 under a higher flow regime. Since travel time is only measured on the survivors, and in 1991 and 1992 few smaller PIT tagged fall chinook survived to Lower Granite Dam. the distribution of travel time estimates are not truly representative of the whole population in those two years. For these reasons, we recommend you use the travel time/flow relation based on the 1993 data in your Model rather than the travel time/flow relation based on 1991 data that is currently in your Model.

778-93.tb

Wild Snake River fall chinook.

Snake River fall chinook migrated over a much longer period in 1993 than in 1991 and 1992 (Figure 1). Based on PIT tagged detections of wild fall chinook released in the Snake River, the middle 80% of the 1993 migration extends twice as long as in the previous two years (Table 1). The midpoint of the migration in 1993 occurred on July 21, the same day as in 1991, and a month later than in 1992. In each year the 10% date of passage at Lower Granite Dam occurred shortly after river temperatures reach 60°F at the dam. In 1993, the 10% passage date occurred 19 days later than in 1992 and 11 days earlier than in 1991. The very early start of the 1992 migration was due to a very mild winter resulting in early emergence, and warmer than average springtime river temperatures. The start of the migration in 1993 is earlier than in 1991, but both years had cooler than average water temperatures, and therefore may be somewhat later than the norm.

Table 1. Snake River fall chinook passage timing at Lower Granite Dam based on PIT tag detections of USFWS marked fish.

Year	10%	50%	90%	Duration[1]
1993	6/25	7/21	8/18	54 days
1992	6/06	6/19	6/30	24 days
1991	7/06	7/21	8/02	27 days

[1] Days spanning middle 80% of migration

The date of 90% passage at Lower Granite Dam in 1993 extend past the middle of August, much later than expected based on the previous two years. Flow levels were maintained at 50 kcfs throughout July and into early August, compared to flows dropping below 20 kcfs during these dates in the previous two years. This higher level of flow coupled with lower than average water temperamres during July and August resulted in more fall chinook arriving at Lower Granite Dam than in the previous two years (Table 2). This is particularly true for the fall chinook between 60 mm and 85 mm in length at time of tagging. These fish tend to make up the bulk of the later migrating fall chinook. In 1993 approximately 15% of the fall chinook tagged at 60-65 mm and 17% of the fall chinook tagged at 66-85 mm were detected passing at Lower Granite Dam. These percentages were two to four times higher than in 1991, and four to sixteen time higher than in 1992. This would imply that fewer of the smaller fall chinook

Table 2. Number of PIT tagged fall chinook released in the Snake and Clearwater rivers and detected at Lower Granite Dam

Year	Site	Length at time of PIT tagging			Total
		≤65mm	66-85mm	≥86mm	
1991	Snake R. releases	213	287	238	738
	Lower Granite detections	8	22	34	64
	Percent detected	3.8%	7.7%	14.3%	8.7%
1992	Snake R. releases	340	527	128	995
	Lower Granite detections	3	18	16	37
	Percent detected	0.9%	3.4%	12.5%	3.7%
1993	Snake R. releases	389	745	273	1407
	Lower Granite detections	59	124	62	245
	Percent detected	15.2%	16.6%	22.7%	17.4%
	Clearwater R releases	94	226	47	367
	Lower Granite detections	4	10	3	17
	Percent detected	4.3%	4.4%	6.4%	4.6%

survived to Lower Granite Dam in either 1991 or 1992 than in 1993. The provision of a constant flow around 50 kcfs during most of the 1993 fall chinook migration appears to have provided a migration that is more representative of the overall fall chinook population. This observation is important when considering estimation of fall chinook travel time.

Because travel time is measurable only on the surviving smolts each year, it is important that the cross section of fish being observed at Lower Granite Dam is representative of the population itself. The relative constant detection percentages across the small to large fish in 1993 supports the notion of a representative coverage of the population. However, this is not the case for 1991 and 1992 where there was an obvious reduction in the percentages of smaller fish being observed at the dam. Since smaller fish tend to migrate later and slower, the result of a truncated passage distribution is a bias in the estimation of median travel time for the population as a whole. This problem causes travel time estimates at the same level of flow to be the lowest in 1992, followed by 1991, and then the highest in 1993. For these reasons, only travel time/flow relationships using the 1993 data will be made, The fall chinook were PIT tagged by USFWS beginning around one month before the actual outmigration begins. Tagging commences when fall chinook greater than 60 mm begin to be collected in beach seining operations in the fall chinook rearing areas. Most fall chinook were seined and tagged between May 25 and June 24, and during this period of time around 100 previously PIT tagged fall chinook were re-recaptured. Figure 2 shows that re-recaptured fall chinook were approaching 95 mm in mid-June before leaving the rearing area. None of the fall chinook re-recaptured after June 24 were detected at Lower Granite Dam. The growth rate of fall chinook from the date of their re-recapture to final recovery at Lower Granite Dam averaged 1.45 mm/day. This average was consistent across the time, and was used to back-calculate the date when individual fall chinook would have reached 95 mm. This was the size at which fall chinook were considered active migrants in 1993, a size that is 10 mm larger than in the previous two years. The duration from this migration start date to recovery at Lower Granite Dam was used as an estimate of travel time for fall chinook. Lower Granite dam flows and temperatures were averaged from this date to the date preceding recovery at the dam.

The data for individual fish were grouped prior to regression analyses being conducted. In the first analysis, the migration start dates were stratified into 5-day intervals, and a median travel time and an mean flow was computed using the respective fish entering each strata. In the second analysis, the flow values computed for individual fish were stratified into 5-kcfs intervals for flows up through 75 kcfs and into IO-kcfs intervals for flows above 75 kcfs. Again, median travel time and mean flow was computed with the respective fish entering each strata.

In Figures 3 and 4, the median travel time and mean flow values of each stratum are plotted against the mean serial date (migration start dates). Since flow and serial date variables are correlated, both stratification scenarios provided similar trends over time -- flows decreased and travel times increased over time.

Figures 5 and 6 show the results of relating median travel time to average flow. The respective equations are $TT=14.43+982.10/FLOW$ ($R^2=0.48$, $n=9$) for the first scenario, and $TT=5.10+1535.81/FLOW$ ($R^2=0.72$, $n=11$) for the second scenario. In both stratification scenarios, as flows increased, fall chinook travel times decreased. Confounded in these simple bivariate relations between flow and travel time are the time depended physiological and behavioral changes in the smolts. Fish size and smoltification tend to increase over time, a direction of change that tends to reduce travel times. Flows also are decreasing over time, a trend that tends to increase travel time. The resulting prediction relations embody the joint effect of these two factors even though only flow appears in the equation. Conceptually, if the effect of physiological changes could be removed, the curve will rise at the lower flows and drop at the higher flow, resulting in an even steeper slope to the travel time/flow curves.

Fall chinook were also PIT tagged and released in the Clearwater River in 1993. Based on USFWS researchers, the Clearwater River fall chinook appeared to be about 33 days behind their Snake River counterparts in growth. The detection percentages of Clearwater River fall chinook averaged about one-fourth of that of the Snake River fish (recall Table 2), but no data is available for how the Clearwater River fall chinook fared in 1992.

Figure 1.

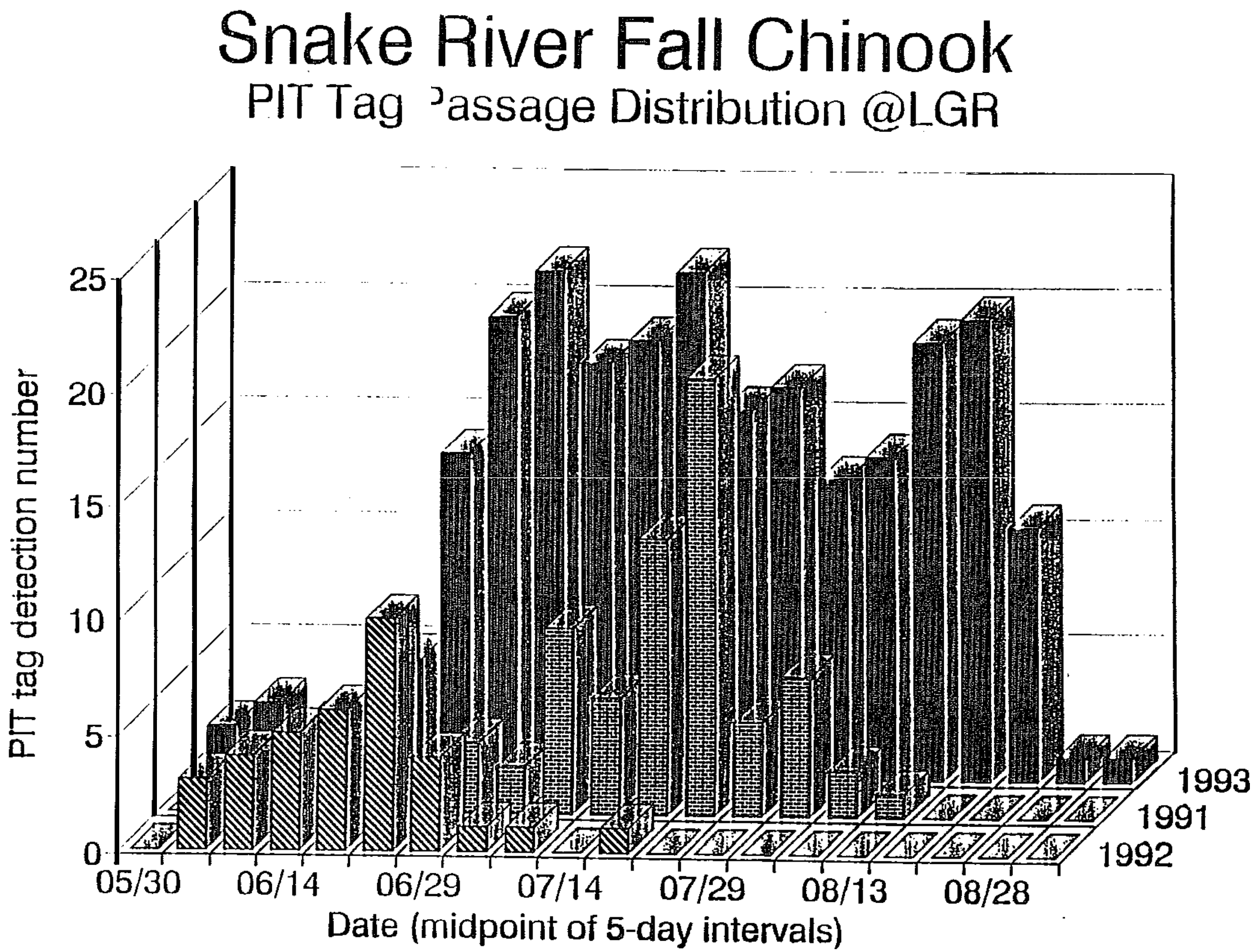

Snake River Fall Chinook
PIT Tag Passage Distribution @LGR
PIT tag detection number
25
20
15
10
5
0
05/30
06/14
06/29
07/14
07/29
08/13
08/28
Date (midpoint of 5-day intervals)
1993
1991
1992

Figure 2.

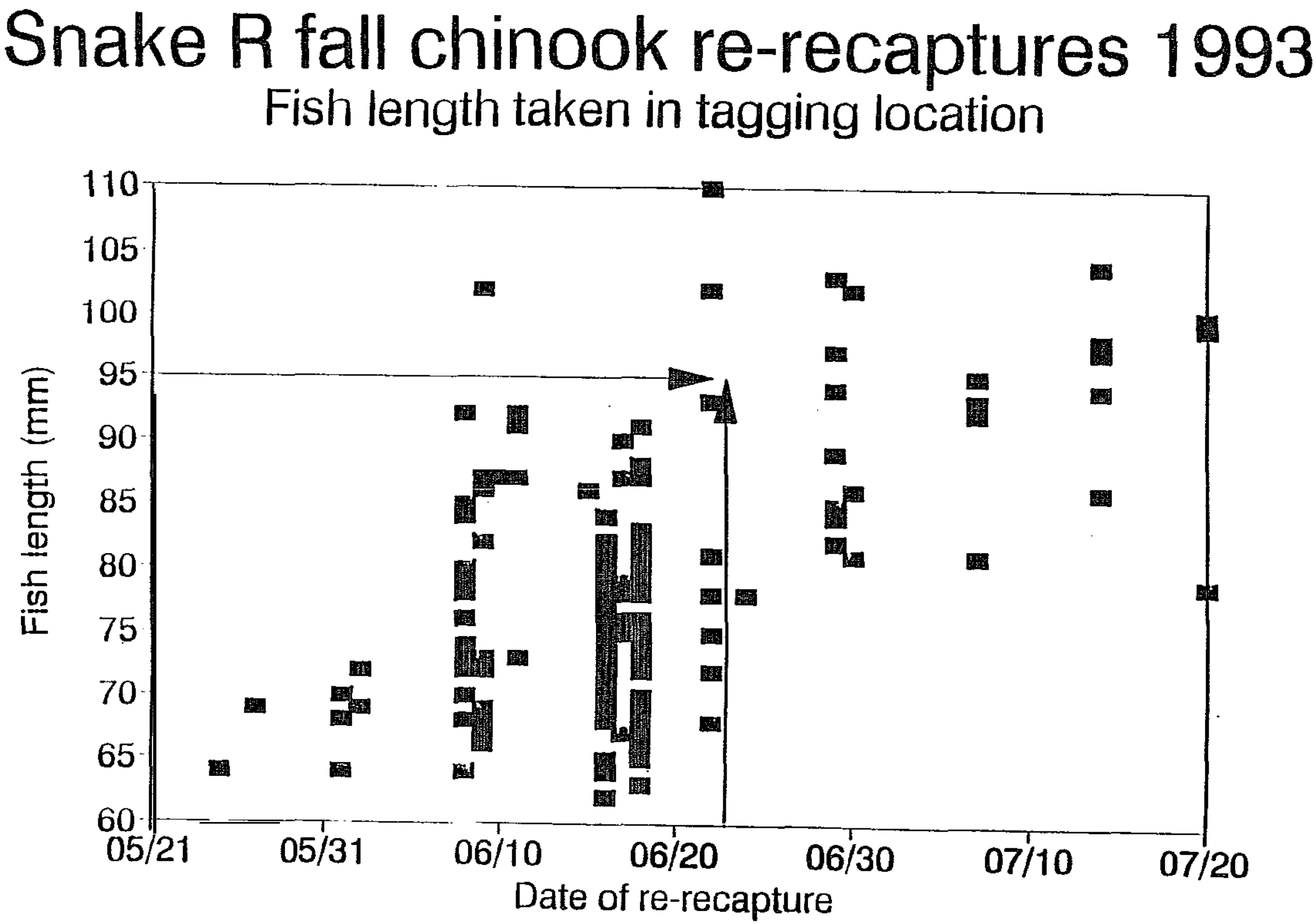
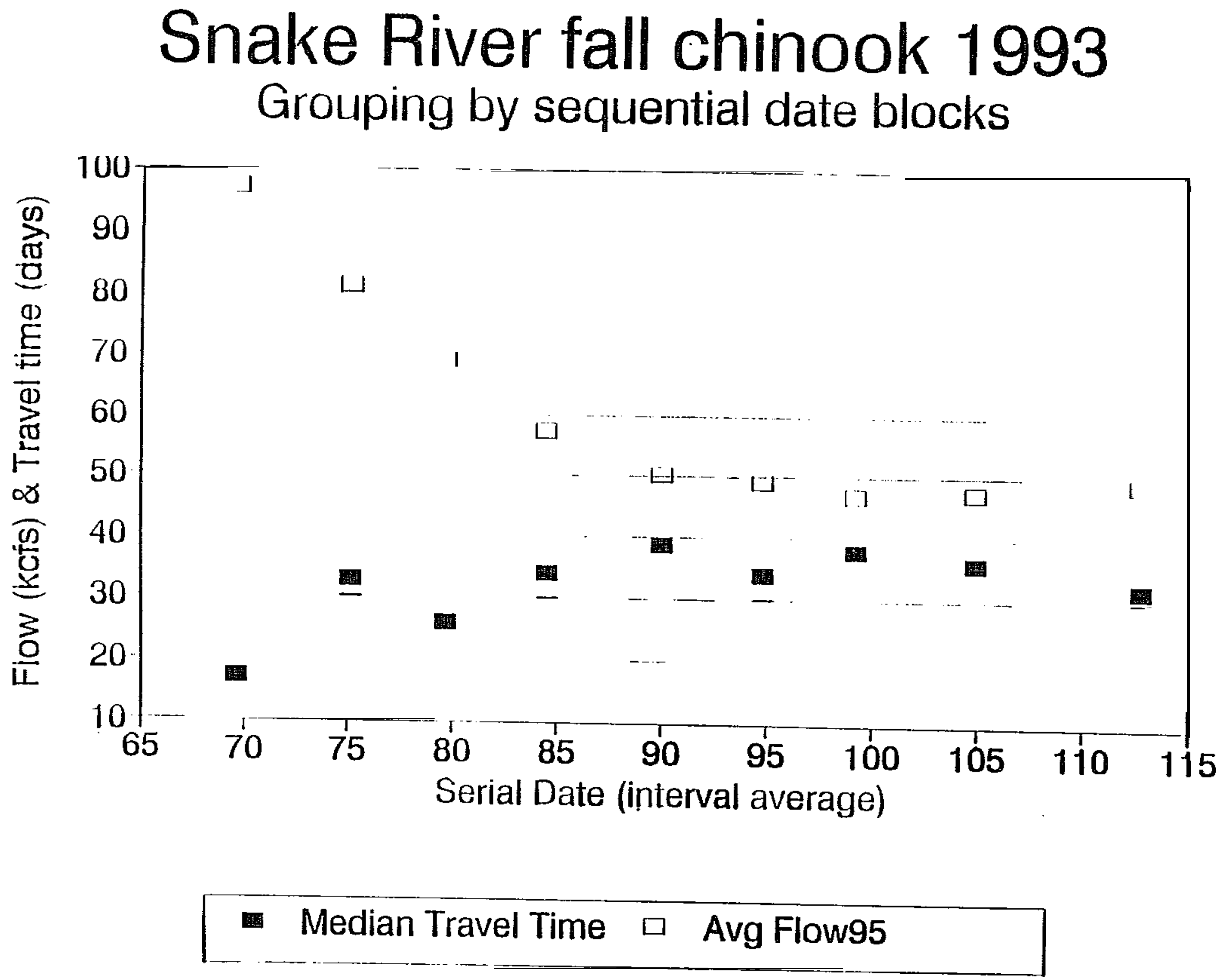

Snake R fall chinook re-recaptures 1993
Fish length taken in tagging location
Fish length (mm)
110
105
100
95
90
85
80
75
70
65
60
05/21
05/31
06/10
06/20
06/30
07/10
07/20
Date of re-recapture

Figure 5.


Snake River fall chinook 1993
Grouping by sequential date blocks
Flow (kcfs) & Travel time (days)
100
90
80
70
60
50
40
30
20
10
65
70
75
80
85
90
95
100
105
110
115
Serial Date (interval average)
Median Travel Time
Avg Flow95

Snake River fall chinook 1993

Grouping by flow intervals

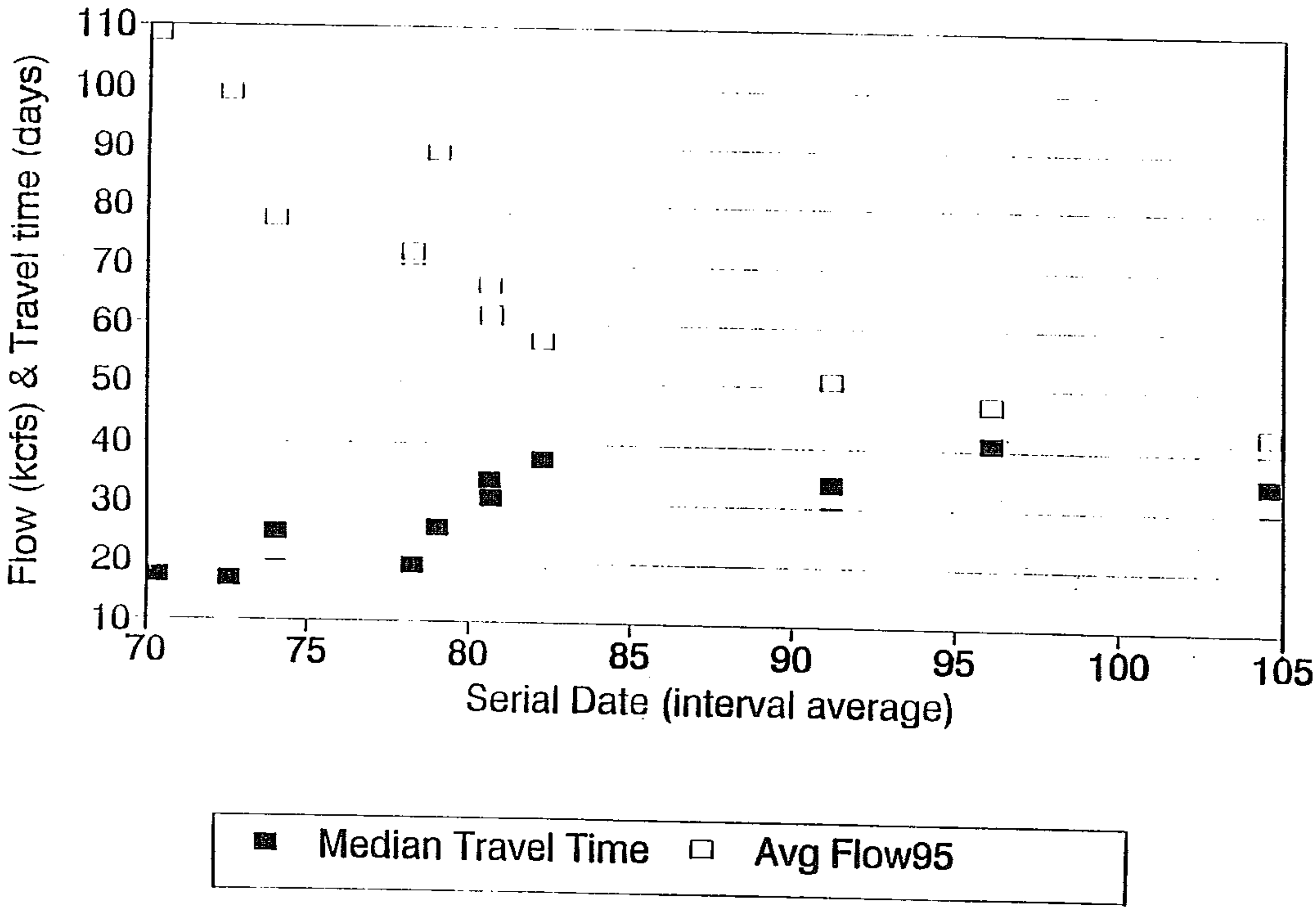


Figure 5

Snake River fall chinook 1993

Grouping by sequential date blocks

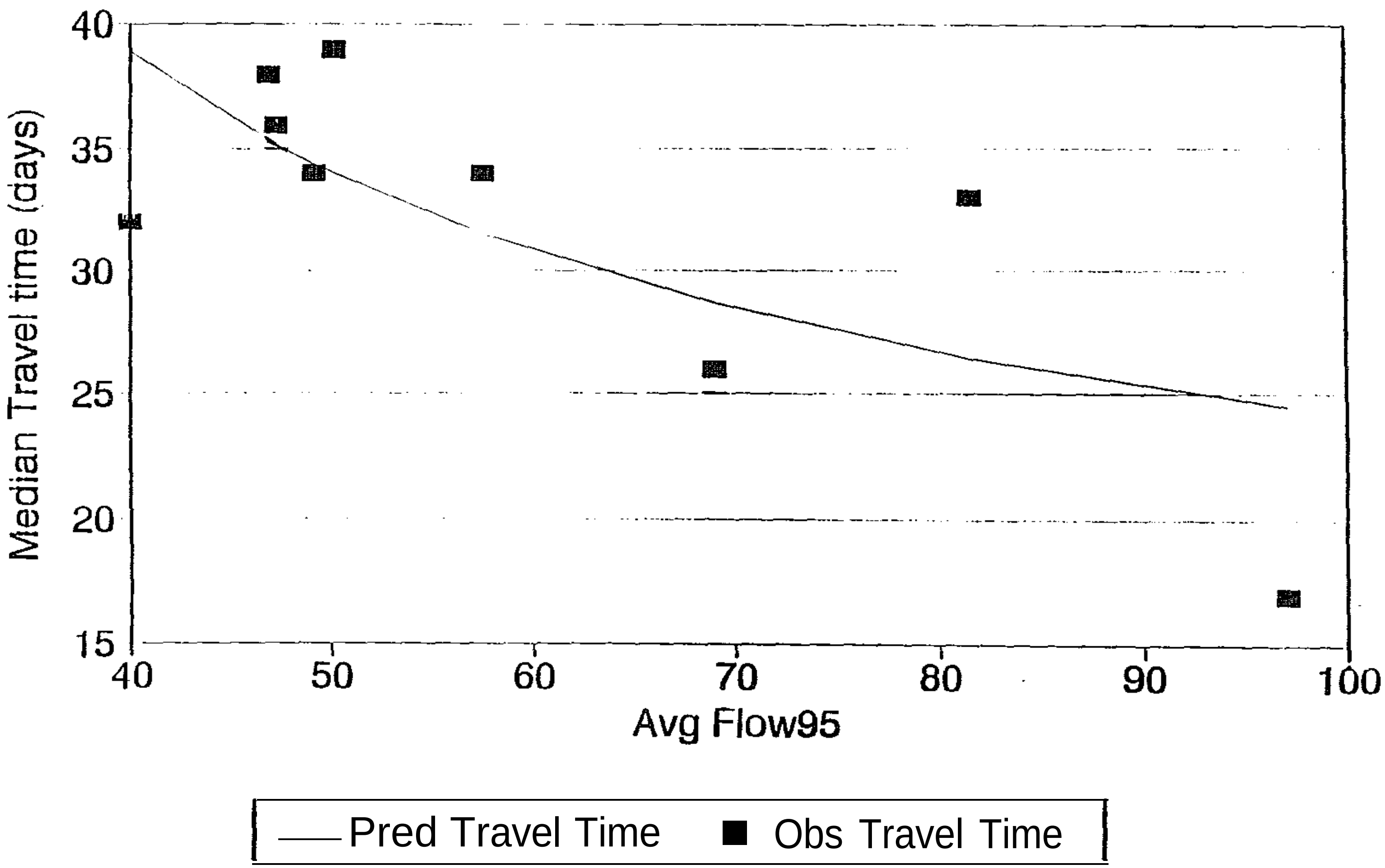
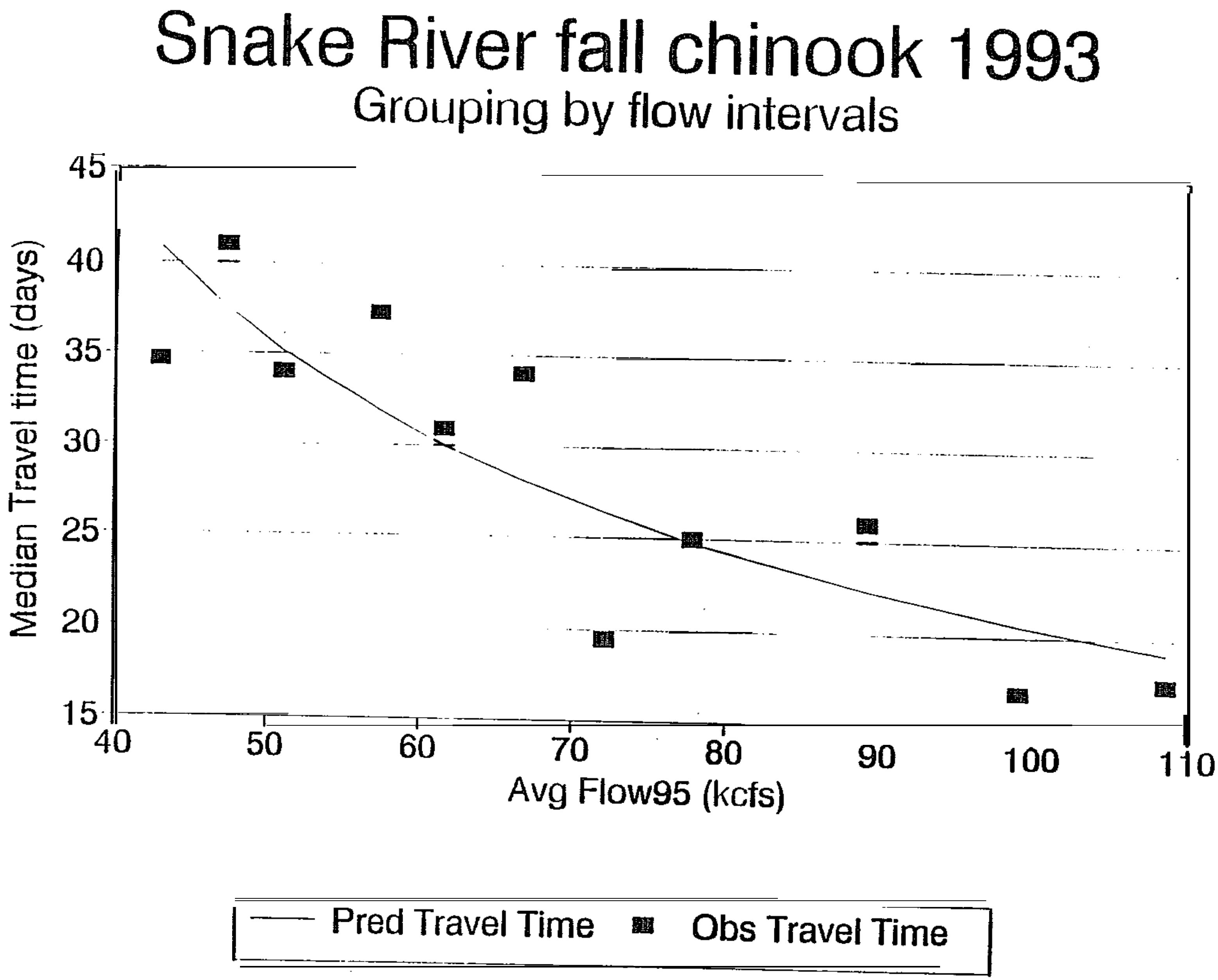


Figure 6.



Snake River fall chinook 1993
Grouping by flow intervals
Median Travel time (days)
45
40
35
30
25
20
15
40
50
60
70
80
90
100
110
Avg Flow95 (kcfs)
Pred Travel Time
Obs Travel Time

11

Assuming active migrant at 95 mm in 1993

Serial Interval	Eishnum	Median Grpn	Avg Grpn	Grpflow	Grptemp	Grpsenal	invflow	Pred i-r
68-72	12	17	20.0	97.2	56.5	70	0.0103	24.5
73-77	19	33	31.6	61.6	59.6	76	0.0123	26.5
78-82	41	26	29.7	69.0	60.7	80	0.0145	26.7
63-57	42	34	323	57.5	61.1	85	0.0174	31.6
87-92	39	39	33.1	50.2	61.7	so	0.0199	34.0
93-97	21	34	33.4	49.2	61.8	95	0.0203	34.4
98-102	16	36	33.5	47.0	62.5	99	0.0213	36.3
103-I 07	7	36	36.4	47.3	62.9	105	0.0211	35.2
108+abov	9	32	32.7	40.1	64.7	113	0.0260	36.9

Regression Output:

constant		14.42762
Std Err of Y Est		5264863
R Squared		0.476649
No. of Observations		9
Degrees of Freedom		7
X Coefficient(s)	982.0956	
Std Err of Coef.	368.601	

Intervals are 5 kcfs to but nor Including 75 kcfs

Intervals are 10 kcfs from 75 kcfs ano above

Flow Interval	Number fish	Avg Grptt	Median Grptt	Grpflow	Grp Avg Taglen	Grp Avg Reclen	Grpsenal	Invflow	Pred i-r
40-44	10	32.6	34.7	42.9	76.4	154.0	104.5	0.0233	40.9
45-49	30	35.4	41 .o	47.3	75.5	151.5	95.1	0.0211	37.5
SO-54	69	33.1	34.0	51.1	74.4	134.5	91.2	0.0196	352
55.59	22	34.3	37.3	57.3	79.9	139.5	62.3	0.0175	31.9
60-64	23	34.5	31.0	61.7	53.2	136.6	50.7	0.0152	30.0
65-69	9	35.0	34.0	55.5	61.1	121.5	50.7	0.0150	25.1
70-74	12	21.2	19.5	721	75.2	124.7	75.3	0.0139	25.4
75-54	3	24.0	25.0	77.9	92.7	130.7	74.0	0.0126	24.5
65-94	9	29.3	26.0	69.3	55.2	104.7	79.0	0.0112	22.3
95-I04	12	23.6	17.0	99.1	55.5	116.0	72.6	0.0101	m.6
105-114	5	18.5	17.5	105.7	95.0	114.0	70.3	0.0092	is.2

Regression Output:

Constant	5.1
Std Err of Y Es!	4.635463
R Squared	0.719614
No. of Observations	11
Degrees of Freedom	9

X Coefficient(s)	1535.513
Std Err of Coef.	319.3961

Appendix C:

1993 Smolt Migration Timing Plots

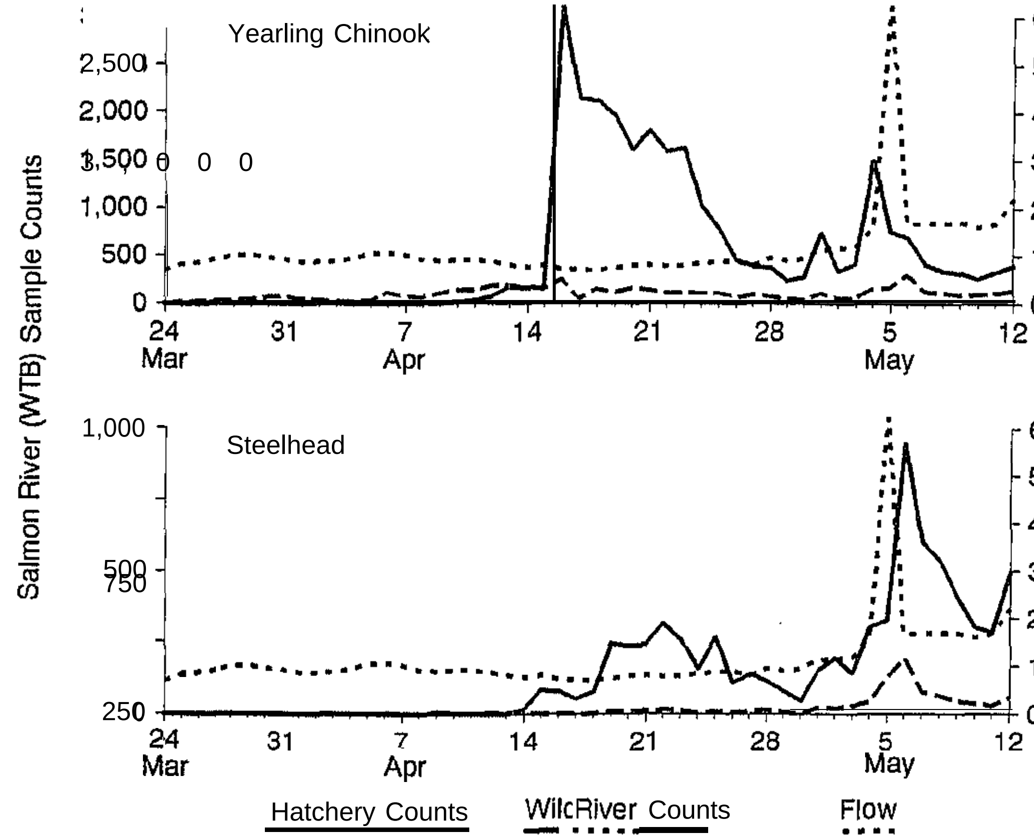


Figure 1a. **Smolt** migration **timing** at tbe Salmon **River** trap with associated **flow,** 1993.

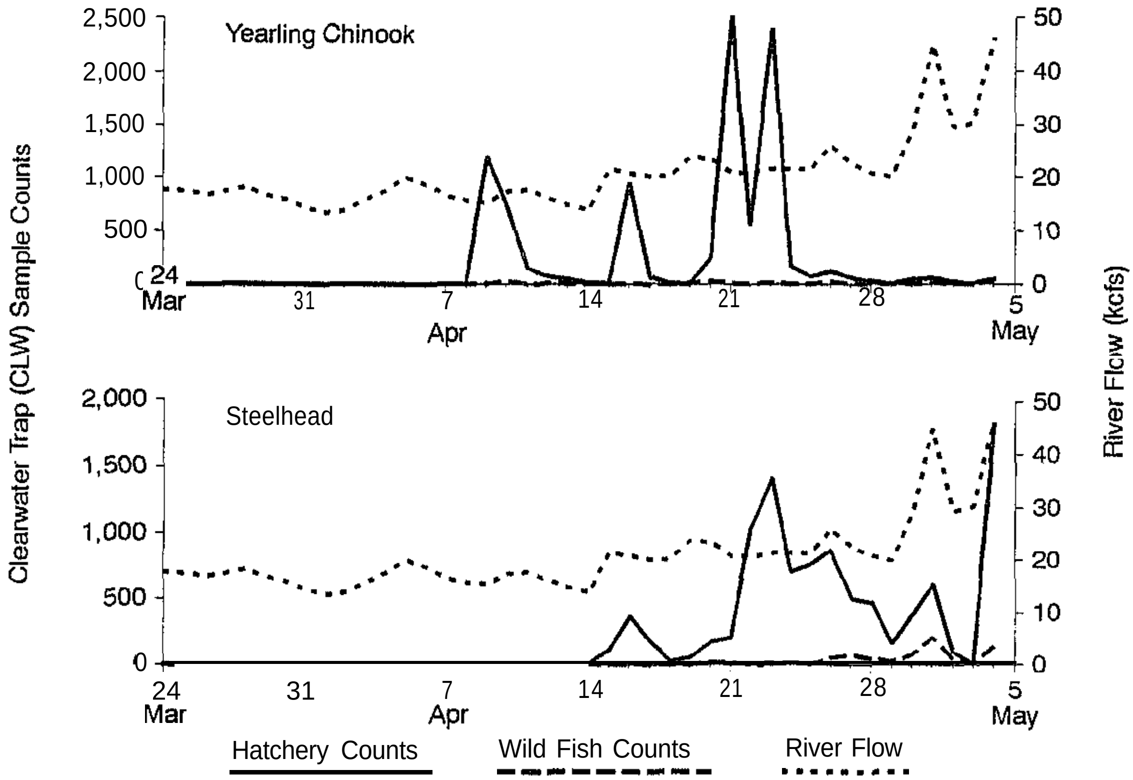


Figure 1b. **Smolt** migration timing at **Clearwater** River trap, with associated flow, 1993.

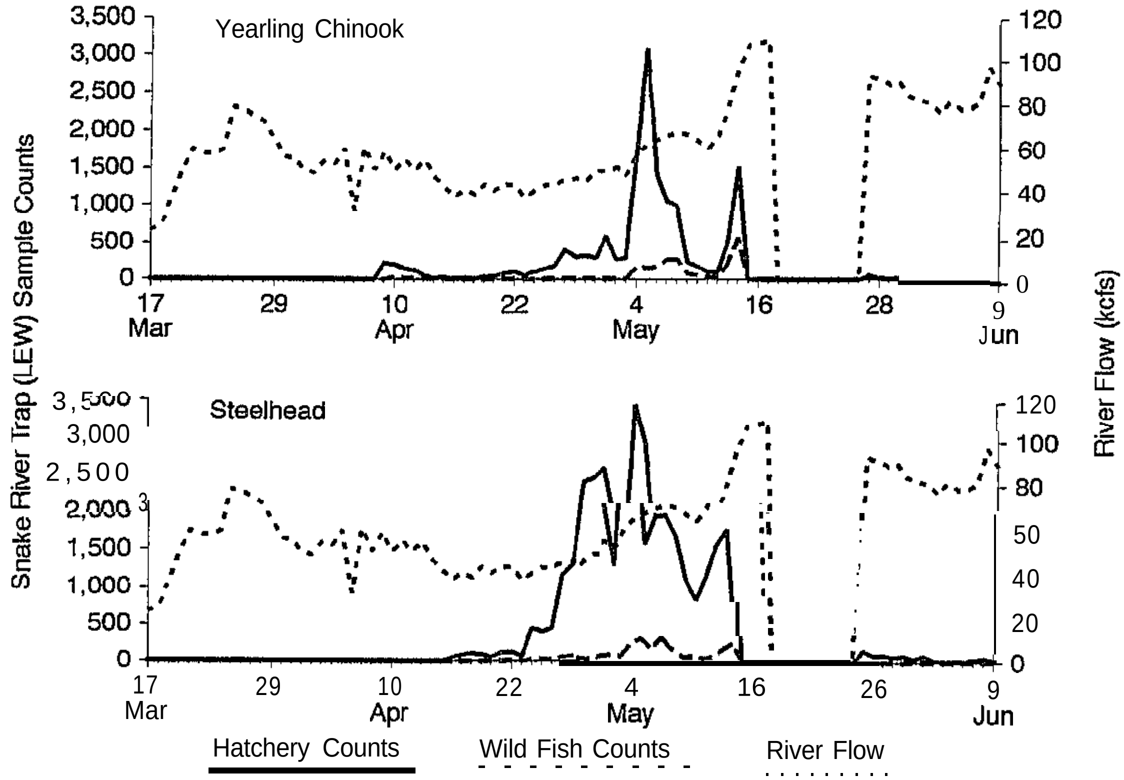


Figure 2. **Smolt migration** timing at Snake River trap, with associated flow, **1993.**

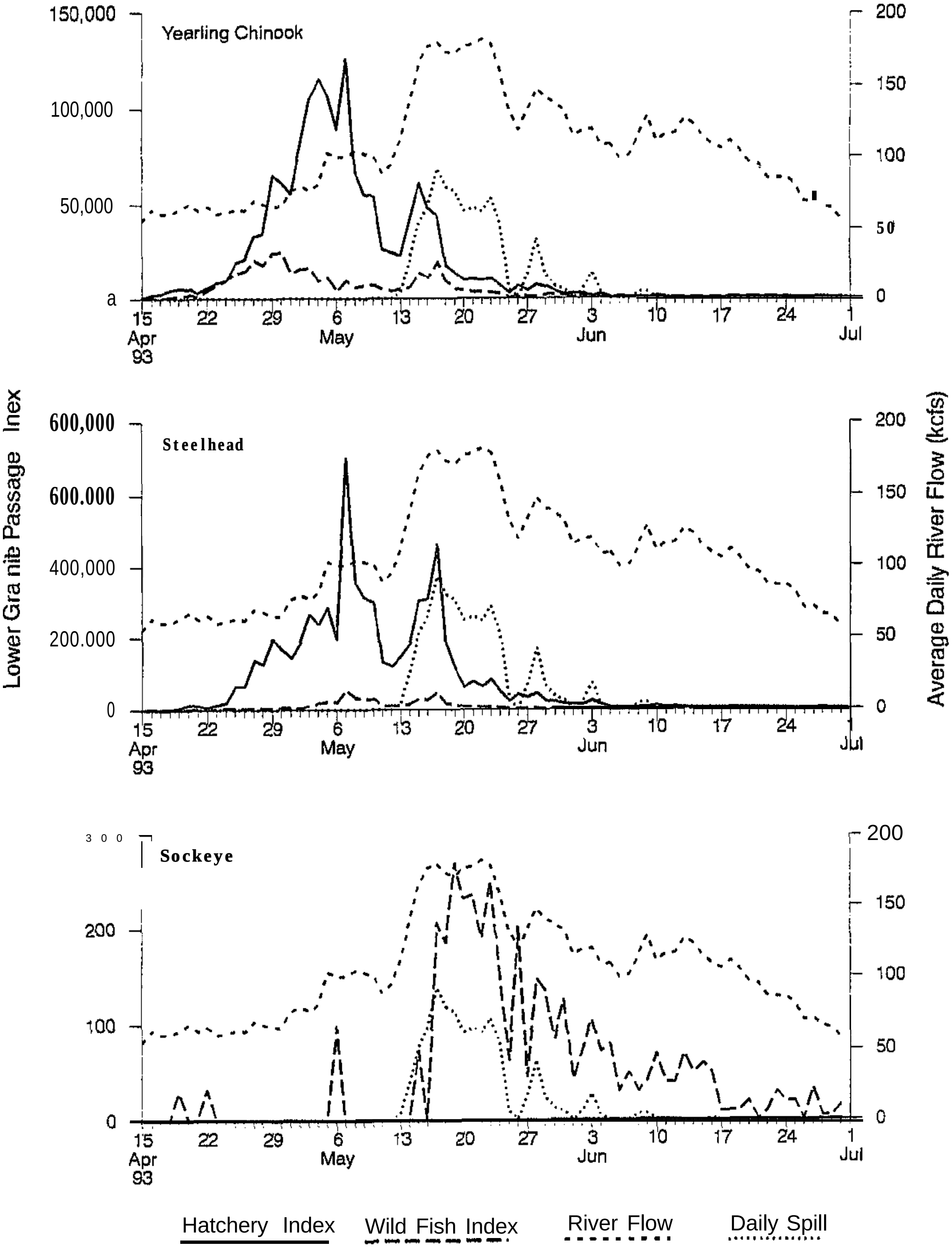


Figure 3. **Smolt** migration timing at Lower Granite Dam, with associated **flow** and **spill,** 1993.

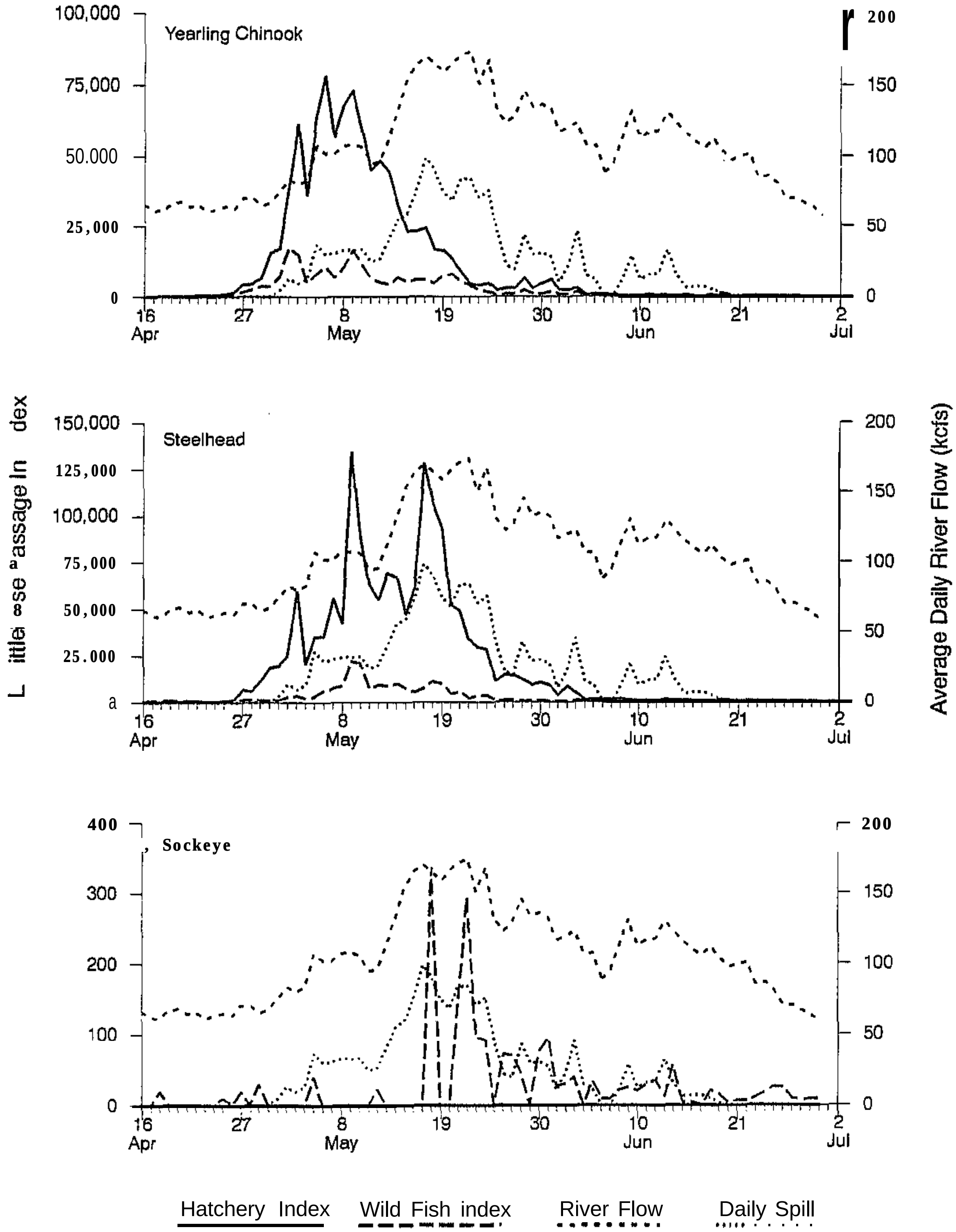


Figure 4. **Smolt** migration timing at Little Goose Dam, with associated flow and **spill,** 1993.

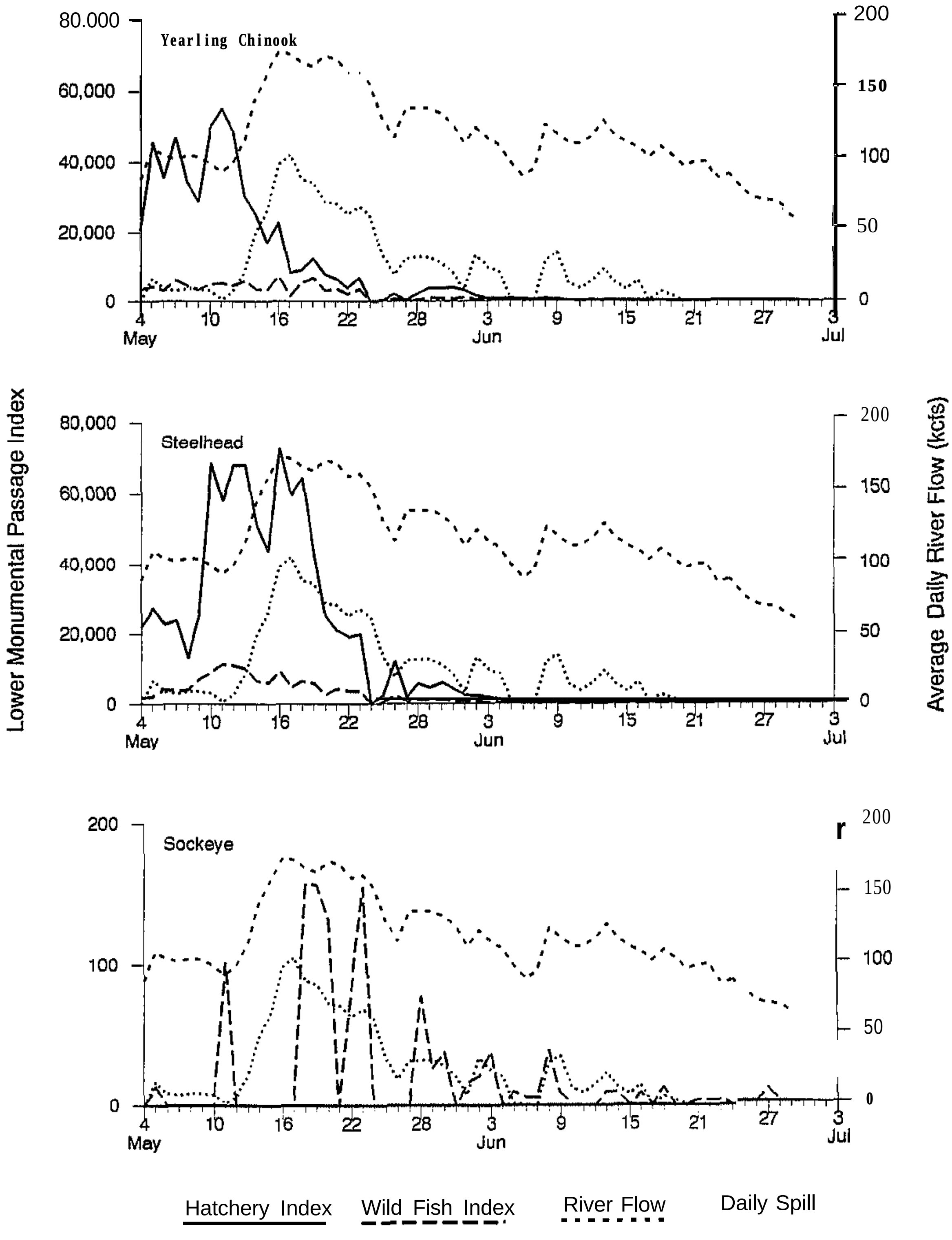


Figure 5. **Smolt migration timing at** Lower Monumental Dam, with associated flow and **spill,** 1993.

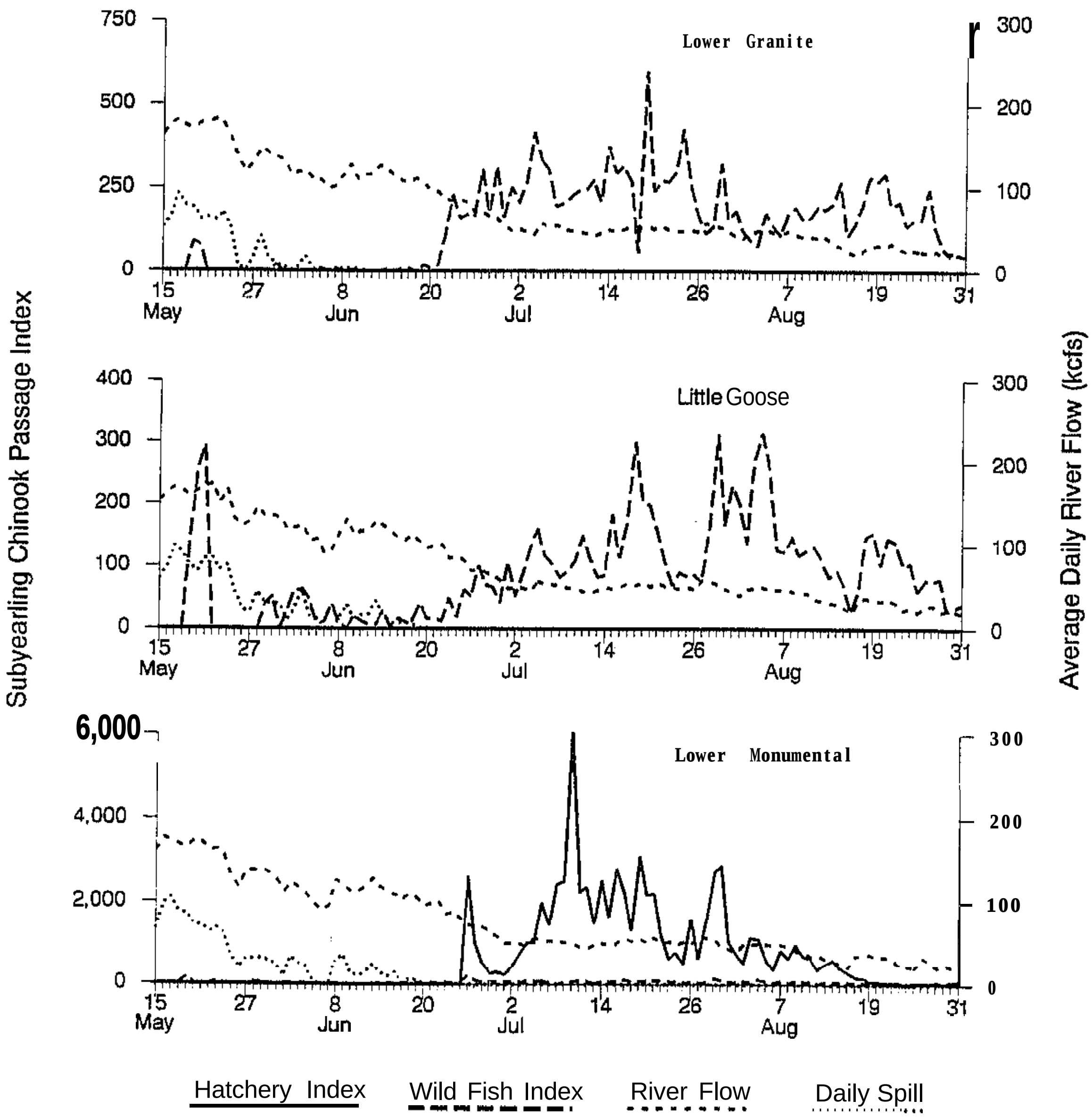


Figure 6. Subyearling smolt migration timing at Snake River sites with associated flow and spill, 1993.

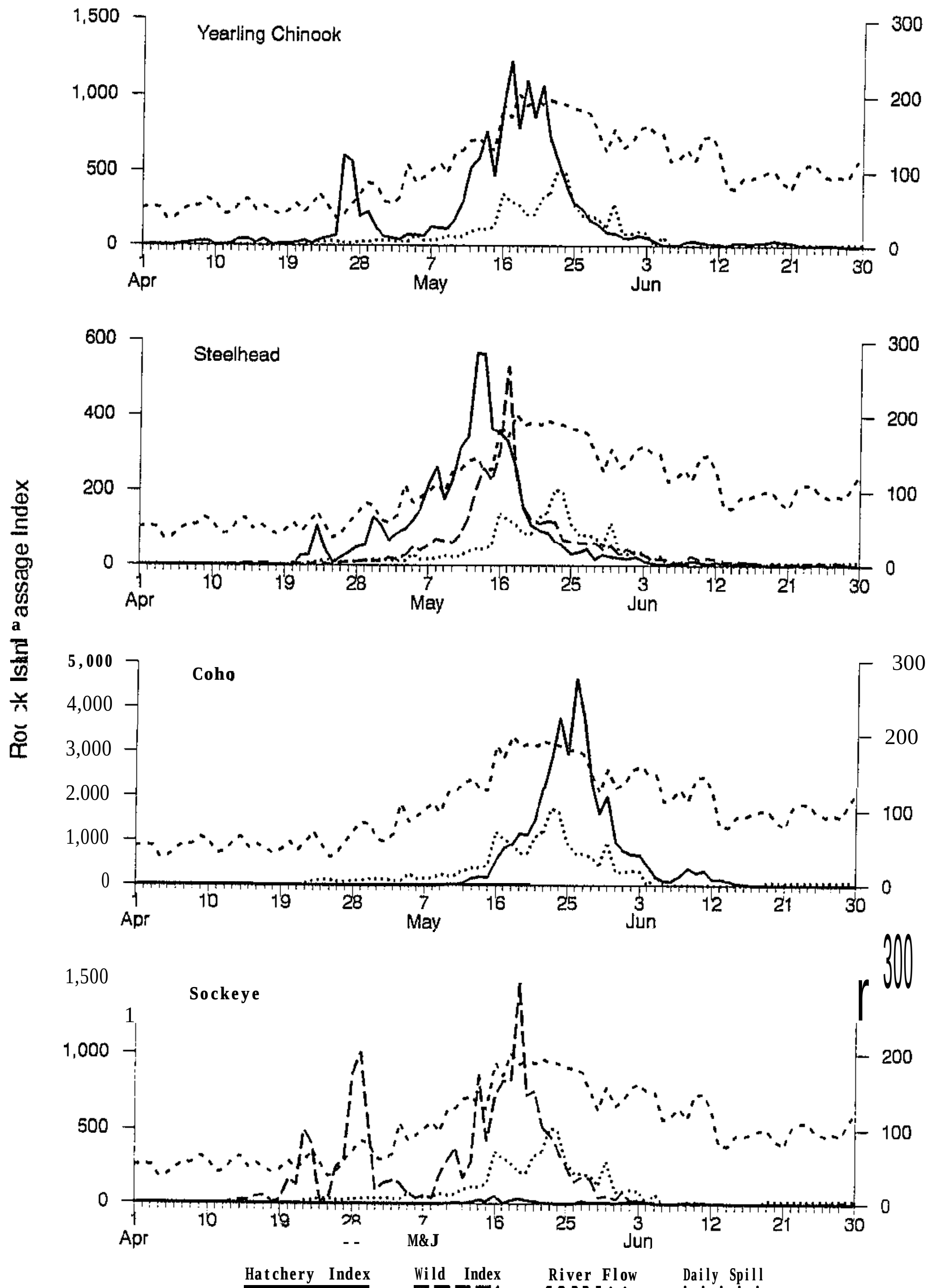


Figure 7. **Smolt** migration timing at Rock Island Dam, with associated flow and spill, 1993.

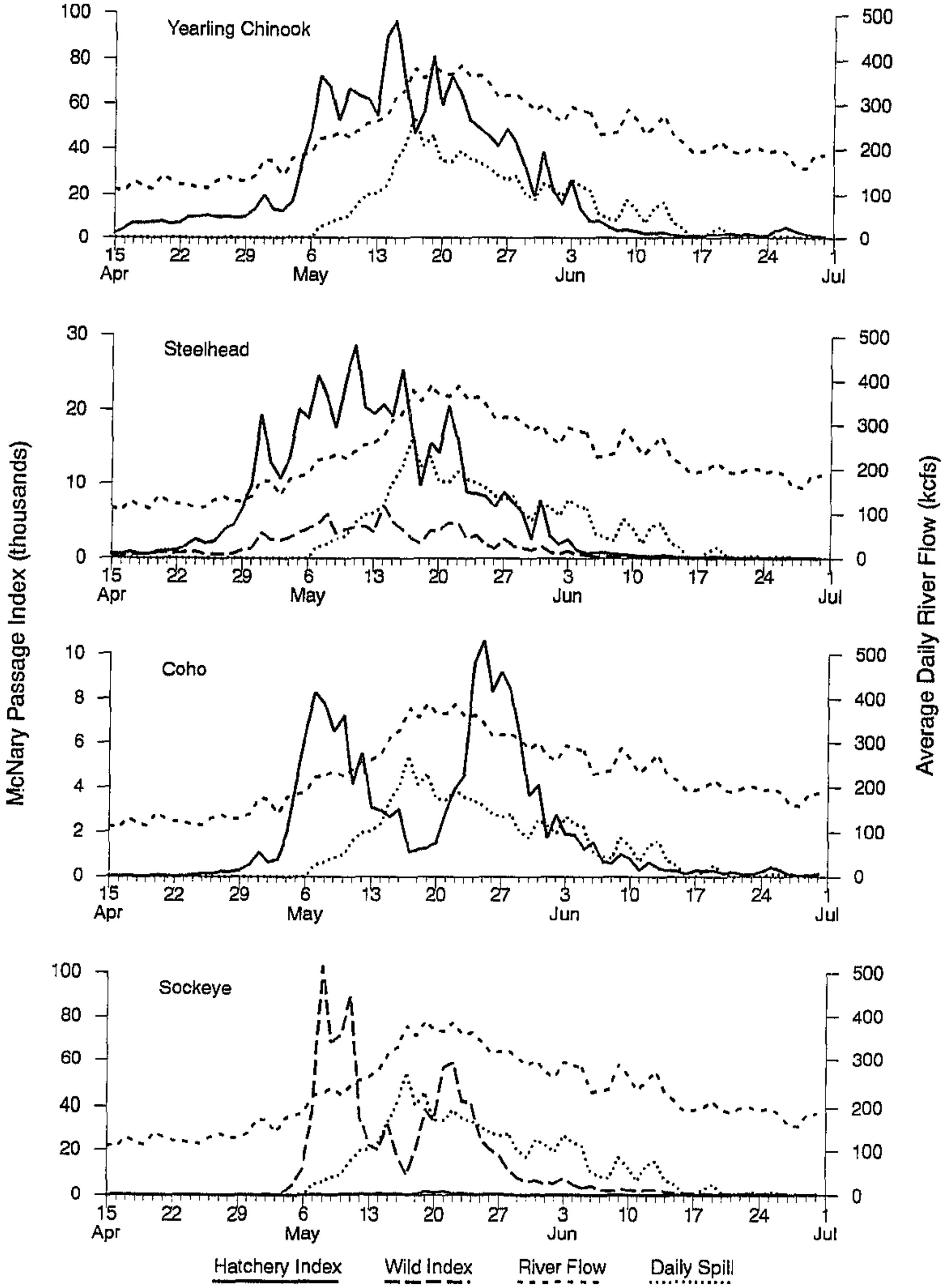


Figure 8. Smolt migration timing at McNary Dam, with associated flow and spill, 1993.

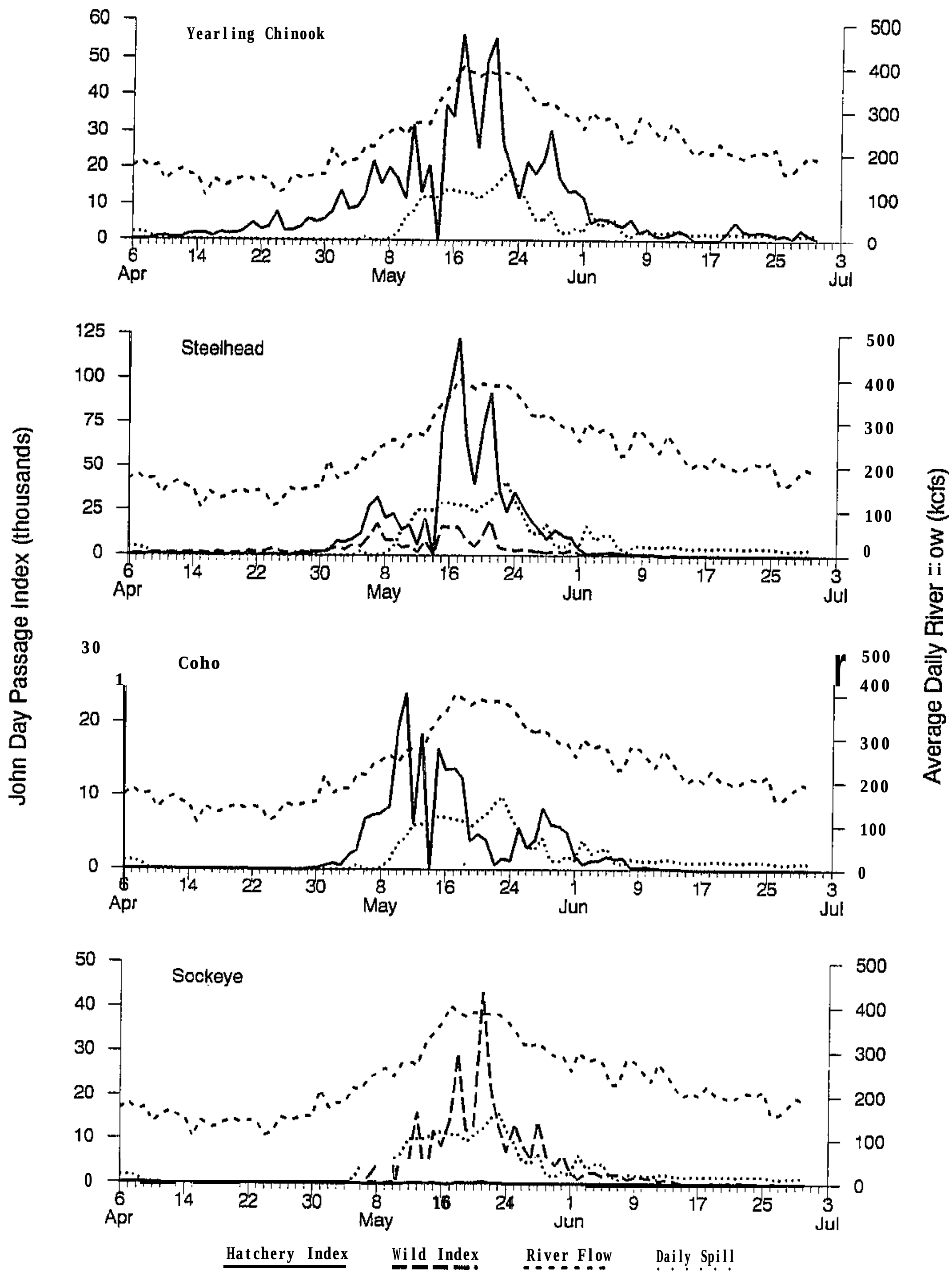


Figure 9. Smolt migration timing at John Day Dam, with associated flow and spill, 1993.

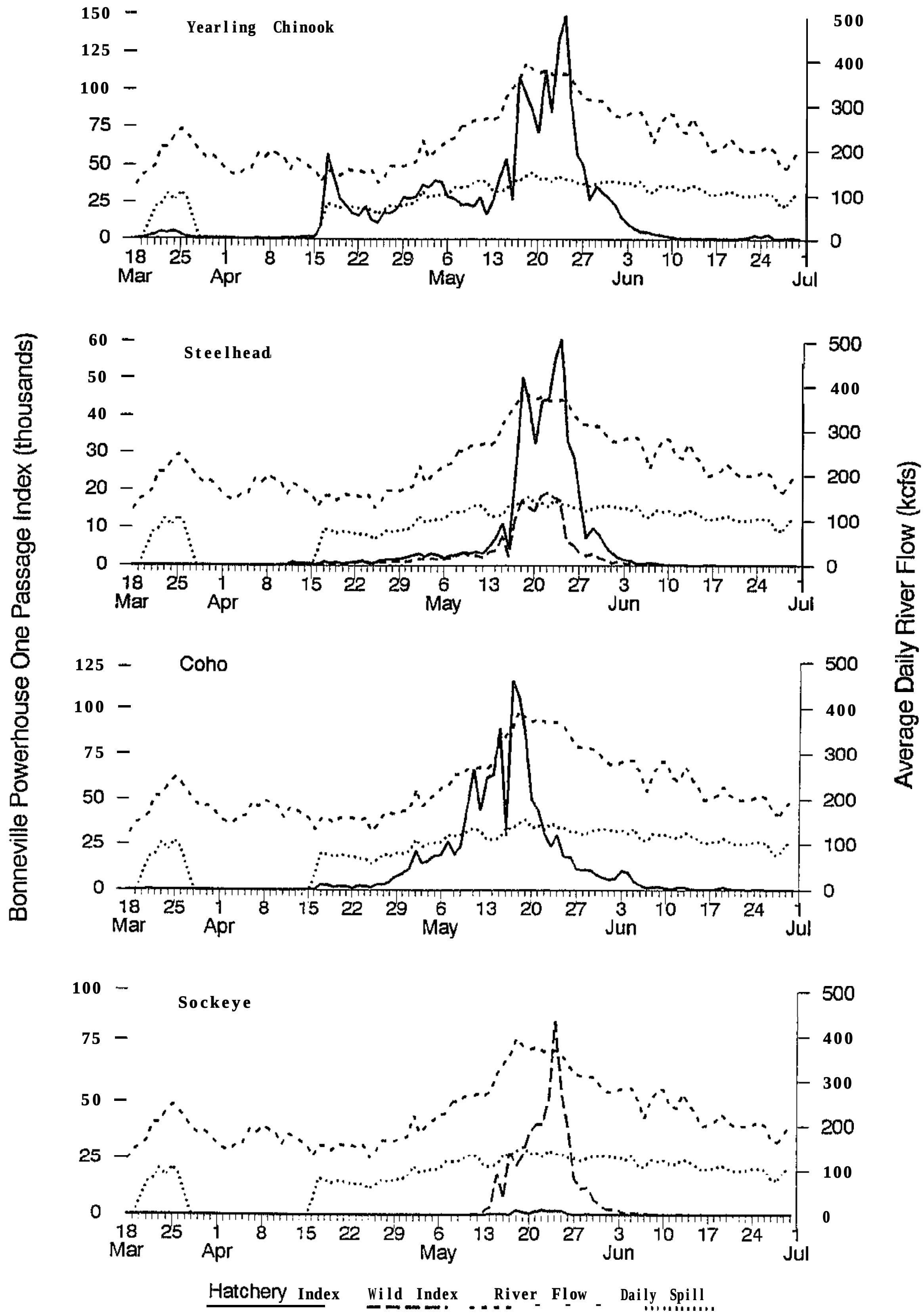


Figure 10. Smolt migration timing at Bonneville Dam, powerhouse one, with associated flow and spill, 1993.

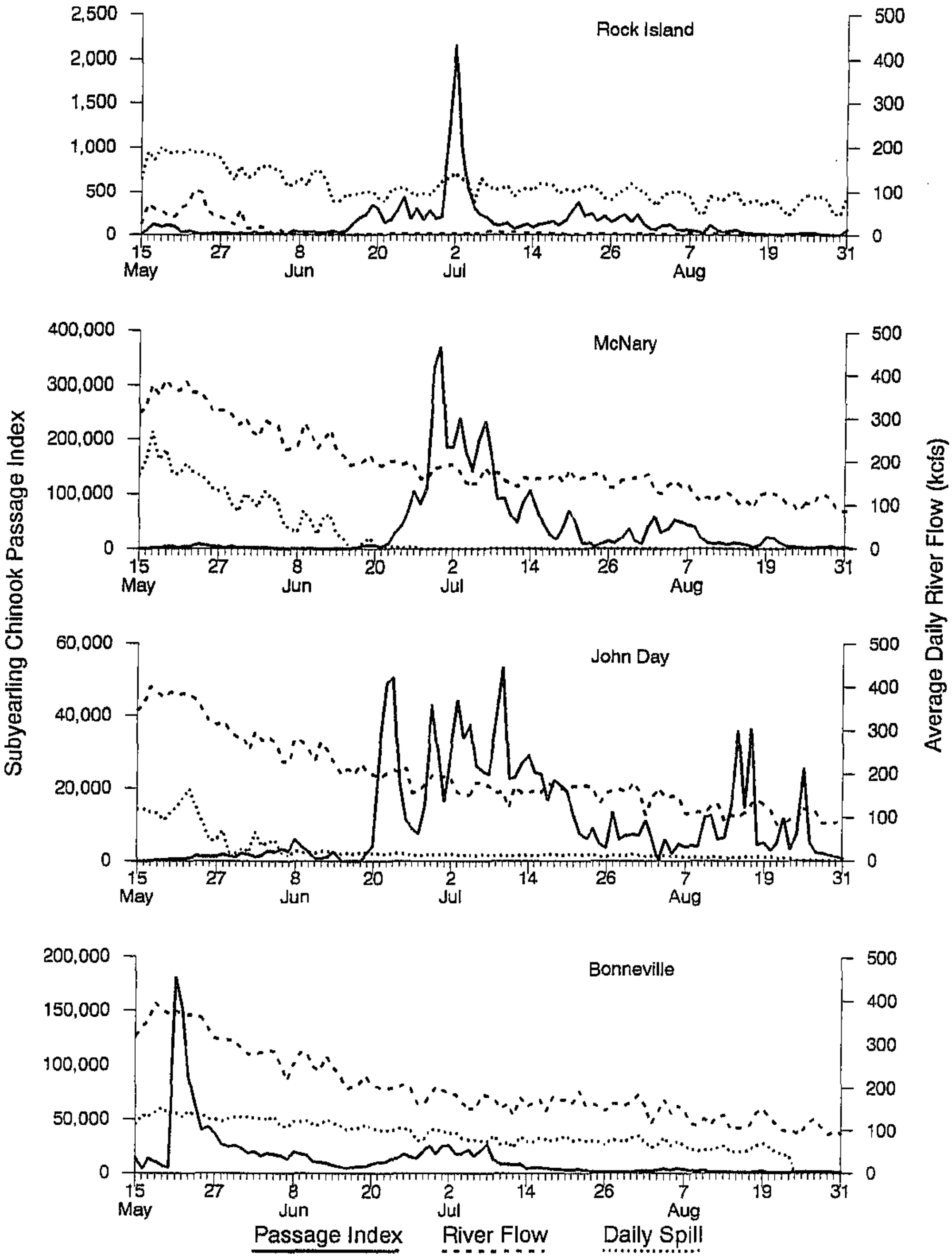


Figure 11. **Subyearling smolt** migration **timing** at Columbia River sites with associated **flow** and spill, **1993.**

Appendix D:

1993 Smoltification Development (ATPase) Tables

Table D-l. 1993 Spring ATPase* data (from USFWS report dated 6/8)

site	Date	Hatchery Spring Chinook	Spring Chinook	Wild Spring Chinook	Steelhead	Wild Steelhead
McNary Dam	04/21		13.8			
	04/28		15.9		12.9	20.9
	05/04		17		16.7	19.8
	05/12	20.9	19.4			
	05/19		21.4		19.2	20.1
	05/26	15.3	19.2			11
Rock Island Dam	04/26	7.3	6.9			
	04/27	8.9	8			
	04/28	9.1	10.7			
	04/29	10.7	10.4			
	05/03	9.2	13.5			
	0904	12.3	10.7			
	05/05	9.6	9			8.1
	05/06	8.5	9.4			
	05/10	20.2	15.6			
	05/17	18.8	18.4			
	05/24	17.8	15			
Clearwater River Trap	04/12	6.9		10.6		
	04/14	6.3		11.9		
	04/16	9.5				
	04/17			12.3		
	04/19	6.9		12.2		
	04/21	10		14		
	04/23	8.9		11.9		
	04/26	10.9		13	12.9	
	04/28	9.1		12.8		11.8
	04/30	10		12.4		
	05/03	13.8		17.6		
Snake River Trap	04/12	8.4		14.5		
	04/14	10.1		10.6		
	04/16	12.7		17.4		
	04/19	8.5		16.6		
	04/23	11.2		19.2	13.5	
	04/26	9.8		16		
	04/28	10.8		19.5		
	04/30	9.6		16.5		
	05/03	16.5		24.7		
	05/05	14		19.6		
	05/07	17.8		22.3		
	05/10	14.3		14		
	05/12	18.8		16.9		
	05/31	15.4		16.3	13.8	
	06/02	17.5		17.7		
	06/04			11.8		

Cont. on next page

Table D-l. 1993 Spring ATPase* data (from USFWS report dated 6/8)

site	Date	Hatchery Spring Chinook	Spring Chinwk	Wild Spring Chinook	Steelhead	Wild Steelhead
Lower Granite Dam	04/27	18.4		25.4		
	04/29	16.3		20.6		
	05/04	18.9		22.7		
	05/06	18.2		21.3		12.4
	05/11	17.4		20.6		
	05/13	17		17.4		
	05/18	18.8		19.3		
	05/20	19.3		21.7		
	05/25	19.3		17.9		
	05/27	16.6		19.6		
	06/01	19.5		21.2		20.7
	06/03	19.6		21.9		
Little Goose Dam	04/26	17.9				
	04/28	18.5				10.8
	04/30	18.8				
	05/03	22.4				
	05/05	20.4				
	05/06	23.1				
	05/07	22.2				
	05/10	15.8				
	05/12	22				
	05/13	23.6				
	05/17	21.6				
	05/19	19.8				15.3
	05/21	20.9				
	05/24	19.9				
	05/26	19.4			16.3	19
	05/28	22.1				
Salmon River Trap	04/06			14.7		8.1
	04/07			13.2		
	04/13	9.8		12.4		
	0415	10.2		14	1.8	
	04/20	7.1		14.6		
	04/22	7		16		
	04/27	8.9		13.4		
	05/04	14.7		16.4		
	05/06	16.3		15.9		
	05/11	13.1		13.1		

*** ATPase units = pmoles P_i * mg $Prot^{-1}$ * hr^{-1}**

Table D-2. 1993 Fall ATPase data		
Site	Date	Fall Subyearling
Bonneville Dam	07/15	16.9
	07/22	22.6
	07/28	23.3
	08/05	24.2
	08/11	21.6
	08/18	18.5
	08/25	18.6
	09/02	17.3
	09/08	19.3
John Day Dam	06/22	16.2
	06/29	19.4
	07/06	22
	07/13	20
	07/20	22.6
	07/27	20.8
	08/03	22.7
	08/10	21.9
	08/17	13.6
	08/24	15.5
	08/31	13.5
McNary Dam	06/16	21.8
	06/23	21
	06/30	18.9
	07/07	16.4
	07/14	22.3
	07/21	21.5
	07/27	20.1
	08/04	21.9
	08/11	18.2
	08/18	17.3
	08/25	14.4
	09/01	17.7

Appendix E:

1993 Summary Travel Time Tables

Table I. 1993 travel time characteristics of PIT tagged fish released at the Clearwater River trap and detected at Lower Granite Dam.

Release Dates Range	Release Dates Median	Travel Time (days) Min.	Travel Time (days) Med.	Travel Time (days) Max.	Confidence Limits (95%) Lower	Confidence Limits (95%) Upper	Number of Fish Released	Number of Fish Detected	Percent Detected	Lower Granite Flow (kcfs)	Lower Granite Temp (°F)
Hatchery Chinook											
	04/09	4.8	22.7	34.1	20.2	25.1	103	28	27.2%	65.5	48.8
	04/10	8.7	22.8	35.6	19.5	25.7	100	43	43.0%	65.8	49.c
	04/l1	7.7	24.4	42.3	20.9	27.5	116	35	30.2%	67.6	49.3
	04/12	5.7	23.1	49.0	20.4	30.1	69	24	34.8%	67.5	49.3
04/13-04/15	04113	7.0	24.3	46.9	17.7	30.6	74	21	28.4%	70.4	49.6
	04/16	4.6	16.6	24.9	13.9	17.8	100	45	45.0%	66.1	49.5
04/17-04/19	04/07	5.7	14.8	27.5	12.4	17.5	80	33	41.3%	65.8	49.4
	04/20	3.9	13.3	23.2	8.7	14.4	101	36	35.6%	67.0	49.7
	04/21	4.6	13.5	23.5	11.0	15.4	100	32	32.0%	70.6	50.0
	04/22	5.6	13.2	22.5	11.6	16.6	97	29	29.9;	71.0	50.2
	04/23	3.7	11.2	21.6	9.1	14.7	100	31	31.0%	69.4	50.2
	04/24	2.7	11.1	24.1	9.8	14.7	100	34	34.0%	72.8	50.4
	04/25	6.5	11.4	24.6	8.9	14.0	72	19	26.4%	76.4	50.5
	04/26	6.2	10.7	39.0	8.3	13.4	97	34	35.1;	79.8	50.5
04/27-04/28	04127	4.3	10.0	18.7	8.3	13.7	97	32	33.0%	80.9	50.7
04/29-04/30	04/30	4.5	8.7	16.4	6.9	11.6	63	24	38.1%	91.0	50.8
	05/01	4.8	12.2	25.6	6.8	15.1	60	18	30.0%	94.7	51.4
05/02-05/04	05/03	2.5	a.7	21.5	5.5	11.8	91	28	30.8%	97.1	51.1
Wild Chinook											
04/09-04/l1	04/10	6.0	14.5	20.3	9.7	16.1	38	18	47.4%	63.5	48.3
04/12-04/17	04/14	7.3	11.1	19.4	7.9	16.6	34	14		62.2	48.8
04/19-04/23	04/20	4.7	10.5	19.5	8.1	12.5	66	25	41.2%		
04/24-04/28	04/26	3.6	7.5	21.2	6.0	11.7	63	27	37.9% 42%	64.9 72.2	49.5 50.4
04/29-05/01	05/01	4.4	6.1	18.7	5.4		45	22	48.9%	89.7	51.0
05/02-05/04	05/04	3.5	8.1	15.9	5.2	9.7 9.7	46	23	50.0%	99.3	51.1
Hatchery Steelhead											
04/12-04/15	04/15	3.5	6.6	22.4	4.6	14.1	27	21		62.8	48.6
	04/16	2.8	8.9	29.9	5.8	12.8	62	43		62.7	48.8
	04/17	2.5	7.2	28.1	5.2	10.1	61			62.9	48.6
04/18-04/19	04/19	3.4	10.1	25.4	8.0	13.0	68	33	48.5%	64.6	49.1
	04/20	3.4	9.0	25.6	7.1	12.7	61	47	77.1%	64.0	49.2
	04/21	2.7	5.6	36.4	4.8	7.4	60	44	73.3;	63.4	49.2
	04/22	2.5	5.1	12.2	4.0	6.7	63	43	68.3%	63.2	49.4
	04/23	2.7	4.9	19.0	4.1	5.7	63	53	84.1%	64.4	49.6
	04/24	2.5	5.3	29.3	4.4	6.8	60	44	73.3%	65.5	49.8
	04/25	2.5	3.9	19.7	3.5	6.6	69	45	65.2%	66.1	49.8
	04/26	2.7	6.6	24.4	5.1	8.5	63	52	82.5%	71.1	50.3
	04/27	2.6	5.3	21.8	4.9	8.6	69	46	68.1%	70.7	50.4
	04/28	2.5	5.2	15.8	4.1	7.7	60	43	76.7%	72.2	50.6
	04/29	2.5	4.5	32.0	3.6	6.3	60		71.7%	75.0	50.8
	04/30	2.3	5.0	17.4	3.7	6.2	60	47	78.3%	81.7	51.0
	05/01	2.1	5.0	35.7	4.5	6.2	60	49	81.7%	87.8	51.0
05/02-05/03	05/02	1.8	4.6	15.3	4.2	5.6	74	56	75.7%	91.2	51.0
	05/04	1.8	4.6	28.1	3.3	6.0	60	51	85.0%	101.7	50.6
Wild Steelhead .											
04/09-04/15	04/12	2.8	4.8	12.6	3.6	6.8	18	12	66.7%	62.3	48.2
04/16-04/20	04/20	3.0	4.8	14.4	3.8	7.1	42	23	54.8%	62.4	48.8
04/21-04/23	04/21	2.5	4.6	9.7	3.3	6.3	33	20	60.6%	62.4	49.2
04/24-04/25	04/24	2.5	3.7	15.1	3.4	4.7	29	18	62.1%	65.5	49.8
	04/26	2.4	4.4	10.8	3.5	5.9	63	38	60.3%	66.9	49.8
	04/27	2.7	3.9	20.1	3.4	4.5	76	51	67.1%	67.8	50.3
	04/28	2.6	4.0	9.6	3.5	4.8	48	32	66.7%	71.3	50.5
	04/29	2.6	4.4	13.1	3.1	5.7	34	16	47.1%	73.8	50.8
	04/30	2.0	3.2	10.5	2.8	4.5	85	59	69.4%	76.8	51.0
	05/01	2.1	3.3	15.1	2.8	3.4	211	146	69.2%	79.4	51.0
05/02-05/03	05/02	1.7	3.3	10.8	2.5	4.2	67	41	61.2%	84.6	51.0
	05/04	1.7	3.3	12.3	2.7	4.4	142	101	71.1%	100.1	51.0

· Detections at Lower Granite do not include tags identified on a single coil.

· Flow and temperature are averaged over the period between tie median date of release and the day preceding the median date of detection at Lower Granite Dam.

● The distance from the Clearwater River Trap to Lower Granite Dam is 37.8 miles.

Table II. 1993 travel time characteristics of PIT tagged chinook released at the Snake River (Lewiston) trap and detected at Lower Granite Dam.

Release Dates Range	Release Dates Median	Travel Time (days) Min.	Travel Time (days) Med.	Travel Time (days) Max.	Confidence Limits (95%) Lower	Confidence Limits (95%) Upper	Number of Fish Released	Number of Fish Detected	Percent Detected	Lower Granite Flow (kcfs)	Lower Granite Temp. (°F)
Hatchery Chinook											
	04/09	4.2	13.4	24.6	10.5	17.5	102	43	42.2%	64.3	48.0
	04/10	3.6	14.7	26.8	12.1	15.8	102	45	44.1%	63.5	48.3
	04/11	4.9	14.2	27.5	12.6	15.8	100	49	49.0%	63.2	48.4
	04/12	4.8	15.4	24.6	11.5	18.7	101	44	43.6%	63.0	48.7
04/13-04/14	04/13	7.9	14.3	27.6	12.0	18.4	78	27	34.6%	62.8	48.8
04/1564/18	04/16	3.6	11.3	24.8	9.8	12.2	98	38	38.8%	63.1	48.9
04/19-04/20	04/20	4.4	9.7	20.4	8.2	11.6	86	38	44.2%	64.1	49.3
	04/21	4.2	8.6	21.6	7.7	10.4	82	37	45.1%	64.4	49.4
	04/22	4.4	8.3	16.6	6.3	10.5	98	39	39.8%	64.4	49.6
	04/23	3.5	6.8	15.5	6.2	8.7	52	30	57.7%	64.7	49.7
	04/24	3.6	6.9	13.7	5.5	8.0	99	42	42.4%	66.4	50.0
	04/25	2.2	6.7	14.3	6.1	7.4	100	40	40.0%	69.1	50.1
	04/26	2.7	5.9	11.3	5.3	7.1	102	44	43.1%	70.3	50.2
	04/27	3.0	5.6	12.7	4.6	6.5	103	44	42.7%	71.6	50.5
	04/28	3.6	5.8	18.2	5.3	7.1	100	37	37.0%	73.5	50.7
	04/29	2.7	4.4	19.7	4.0	5.1	101	42	41.6%	73.8	50.8
	04/30	2.2	4.7	15.1	4.1	5.2	100	47	47.0%	81.7	51.0
	05/01	3.1	4.5	12.6	4.0	5.2	loo	46	46.0%	87.8	51.0
	05/02	2.4	4.4	7.8	4.0	4.7	100	48	48.0%	89.1	51.0
	05/03	2.1	3.5	6.8	3.3	3.9	100	45	45.0%	95.0	51.0
	05/04	1.7	3.4	10.0	2.8	3.9	117	68	58.1%	100.1	51.0
	05/05	I.8	3.8	10.4	3.6	4.3	100	36	36.0%	102.6	50.5
	05/06	2.4	3.9	8.4	3.4	5.0	100	40	40.0%	102.2	50.3
	05/07	2.2	5.2	16.5	4.3	6.5	99	46	46.5%	98.8	51.2
	05/08	1.9	5.4	17.6	4.9	6.1	99	38	38.4%	98.8	52.2
	05/09	2.6	5.4	14.8	4.7	6.2	100	27	27.0%	104.4	53.2
	05/10	2.8	4.4	9.6	3.7	4.8	99	32	32.3%	105.2	54.0
	05111	2.0	3.6	8.2	3.3	4.2	93	19	20.4%	121.7	54.8
	05/12	1.5	2.8	10.0	2.5	3.3	98	31	31.6%	131.6	55.0
	05/13	1.5	2.8	9.1	2.5	3.4	101	30	29.7%	154.7	54.7
	05/14	1.4	2.8	11.5	1.7	3.6	70	16	22.9%	170.8	54.3
	05/27	1.8	4.5	10.8	3.1	5.2	54	24	44.4%	136.4	56.2
05/28-05/30	05/29	1.7	4.5	16.6	2.8	6.3	63	29	46.0%	126.3	56.4
05/31-06/02	06/02	2.5	5.0	17.4	3.8	7.2	58	26	44.8%	109.2	56.0
06/03-06/11	06/08	1.8	5.6	17.4	2.9	9.9	32	14	43.8%	120.4	55.8
Wild Chinook											
04/09-04/10	04110	7.6	Il.7	24.6	9.5	13.3	45	26	57.8%	63.9	48.1
04/11-04/12	04/12	6.5	13.7	22.2	11.2	16.4	46	24	52.2%	62.7	48.6
04/13-04/17	04/14	5.9	10.5	24.1	9.2	12.7	47	29	61.7%	62.2	48.8
04/18-04/22	04/21	3.6	7.2	11.9	5.9	8.5	43	24	55.8%	64.1	49.3
04/23-04/27	04/26	3.6	5.7	11.6	5.0	6.5	60	37	61.7%	70.3	50.2
04/28-04/30	04/29	2.4	4.9	9.1	4.2	5.6	57	28	49.1%	75.0	50.8
05/01-05/03	05/02	2.4	4.4	10.0	3.5	5.2	47	25	53.2%	89.1	51.0
	05/04	1.8	3.5	11.5	2.6	4.6	49	27	55.1%	100.9	50.8
	05/05	1.7	4.7	11.6	3.6	5.4	61	33	54.1%	102.3	50.4
	05/06	2.5	4.6	14.7	3.3	5.4	48	30	62.5%	100.3	50.6
	05/07	2.4	4.8	19.2	3.8	7.5	50	30	60.0%	98.8	51.2
	05/08	2.2	5.4	8.8	3.8	6.2	49	27	55.1%	98.8	52.2
05/09-05/10	05/10	2.8	4.8	12.5	4.6	6.5	78	35	44.9%	115.9	54.2
05/11-05/12	05/12	2.4	4.1	14.4	3.4	5.3	86	30	34.9%	142.0	54.8
05/13-05/14	05/13	1.2	3.5	25.5	2.8	4.3	102	26	25.5%	161.2	54.5
	05/27	2.0	8.4	77.3	5.0	21.3	59	36	61.0%	129.0	56.3
05/28-05/30	05/29	1.4	6.9	66.2	4.3	14.0	66	30	45.5%	121.8	56.3
05/31-06/04	06102	2.5	5.5	41.4	3.7	13.2	57	26	45.6%	108.4	56.0
06/05-06/09	06/08	2.9	13.9	51.8	10.9	18.6	45	26	57.8%	110.9	57.4

- Detections at Lower Granite do not include tags identified on a single coil.
- Flow and temperature are averaged over the period between the median date of release and the day preceding the median date of detection at Lower Granite Dam.
- The distance from the Snake River Trap at Lewiston to Lower Granite Dam is 32.2 miles.

Table III. 1993 travel time characteristics of PIT tagged hatchery steelhead released at the Snake River (Lewiston) trap and detected at Lower Granite Dam.

Release Dates Range	Release Dates Median	Travel Time (days) Min.	Travel Time (days) Med.	Travel Time (days) Max.	Confidence Limits (95%) Lower	Confidence Limits (95%) Upper	Number of Fish Released	Number of Fish Detected	Percent Detected	Lower Granite Flow (kcfs)	Lower Granite Temp. (°F)
04/13-04/16	04/16	2.5	4.1	27.9	3.6	4.9	78	61	78.2%	63.1	48.8
	04/17	2.4	5.3	19.9	4.9	7.7	60	42	70.0%	63.6	48.4
	04/18	1.8	7.0	19.4	4.5	8.2	63	44	69.8%	63.4	48.7
	04/19	3.3	7.1	23.9	4.8	8.2	62	39	62.9%	63.4	48.9
	04/20	2.7	4.6	21.2	4.2	6.5	57	43	75.4%	62.4	48.8
	04/21	2.6	4.8	18.2	3.8	7.0	62	51	82.3%	62.4	49.2
	04/22	2.5	4.3	50.2	3.7	6.8	61	49	80.3%	61.9	49.5
	04/23	1.8	4.7	21.9	3.8	5.7	61	49	80.3%	64.4	49.6
	04/24	2.3	4.4	20.2	3.8	6.0	61	45	73.8%	65.5	49.8
	04/25	1.8	3.7	18.9	3.1	5.2	65	45	69.2%	66.1	49.8
	04/26	1.6	3.1	17.3	3.0	4.6	60	51	85.0%	67.5	49.7
	04/27	2.6	4.2	17.9	3.4	5.6	61	43	70.5%	67.8	50.3
	04/28	2.5	3.5	22.9	3.0	4.5	67	52	77.6%	71.3	50.5
	04/29	1.6	3.0	7.2	2.8	3.1	60	37	61.7%	73.1	50.7
	04/30	1.9	2.9	14.3	2.5	4.0	60	47	78.3%	76.8	51.0
	05/01	1.7	2.8	14.2	2.6	3.1	84	72	85.7%	79.4	51.0
	05/02	1.6	2.9	14.1	2.5	3.9	61	50	82.0%	84.6	51.0
	05/03	1.5	2.8	23.5	2.1	3.2	60	55	91.7%	93.6	51.0
	05/04	1.5	2.2	11.9	2.0	2.8	61	51	83.6%	100.4	51.0
	05/05	1.4	2.4	17.8	2.1	3.1	61	50	82.0%	101.1	51.0
	05/06	1.3	1.8	10.6	1.7	2.2	63	48	76.2%	101.5	50.5
	05/07	1.5	2.0	8.1	1.8	2.1	59	50	84.7%	104.1	50.0
	05/08	1.5	2.7	17.8	2.1	3.2	67	51	76.1%	99.5	50.7
	05/09	1.5	3.1	15.0	2.6	3.6	61	54	88.5%	95.3	52.0
	05/10	1.6	2.8	15.2	2.7	3.1	59	47	79.7%	96.0	53.7
	05/11	1.6	2.4	6.7	2.1	2.8	60	40	66.7%	97.8	54.5
	05/12	1.4	1.8	9.4	1.7	2.5	60	37	61.7%	118.1	55.0
	05/13	1.3	2.6	14.0	2.0	3.5	60	18	30.0%	154.7	54.7
	05/14	1.2	2.1	11.7	1.8	2.4	60	19	31.7%	165.8	54.5
	05/27	1.3	2.2	19.6	1.8	2.9	63	42	66.7%	144.9	56.0
	05/28	1.3	2.1	6.7	1.6	3.7	61	45	73.8%	139.5	57.0
	05/29	1.2	2.8	6.0	2.1	3.5	61	47	77.0%	130.7	56.3
	05/30	1.4	2.1	7.0	1.9	3.1	61	49	80.3%	126.7	56.0
	05/31	1.4	2.5	8.0	1.9	2.6	61	53	86.9%	118.3	56.3
	06/01	1.2	2.2	9.1	1.7	2.7	50	38	76.0%	119.8	56.5
	06/02	1.4	2.5	9.1	2.5	3.0	71	60	84.5%	114.3	56.0
	06/03	1.5	2.0	7.1	1.6	2.6	34	30	88.2%	110.5	56.0
	06/04	1.5	2.5	7.1	2.2	3.7	24	21	87.5%	104.4	56.0
	06/05	1.6	2.8	6.4	2.1	4.0	29	22	75.9%	102.4	56.0
	06/07	1.5	2.1	7.0	1.9	2.7	51	46	90.2%	118.0	56.0
	06/08	1.3	2.3	5.8	2.0	2.8	65	56	86.2%	124.2	56.0
	06/09	1.2	2.8	5.8	1.9	3.1	31	29	93.5%	114.0	56.0
	06/11	1.1	2.2	7.8	2.0	3.3	33	30	90.9%	120.0	55.5
	06/16	1.9	3.2	8.8	1.9	8.8	8	7	87.5%	106.7	58.3

- Detections at Lower Granite do not include tags identified on a single coil.
- Flow and temperature are averaged over the period between the median date of release and the day preceding the median date of detection at Lower Granite Dam.
- The distance from the Snake River Trap at Lewiston to Lower Granite Dam is 32.2 miles.

Table IV. 1993 travel time characteristics of PIT tagged wild steelhead released at the Snake River (Lewiston) trap and detected at Lower Granite Dam.

Release Dates		Travel Time (days)			Confidence Limits (95%)		Number of Fish		Percent	Lower Granite	
Range	Median	Min.	Med.	Max.	Lower	Upper	Released	Detected	Detected	Flow (kcfs)	Temp. (°F)
04/09-04/13	04/11	2.6	4.0	20.5	3.5	5.4	22	16	72.7%	64.8	47.5
04/14-04/18	04/16	2.3	4.8	10.7	3.7	5.9	36	26	72.2%	62.8	48.6
04/19-04/21	04/20	2.6	4.0	14.2	3.4	5.8	39	28	71.8%	62.2	48.5
04/22-04/23	04/22	2.7	3.5	16.9	3.3	4.2	32	25	78.1%	61.9	49.5
	04/24	2.3	3.5	20.8	2.8	5.1	39	23	59.0%	65.5	49.8
	04/25	2.0	3.2	15.3	2.8	4.1	39	28	71.8%	66.2	49.7
	04/26	2.2	2.7	9.1	2.6	3.8	35	23	65.7%	67.5	49.7
	04/27	2.4	3.0	7.7	2.8	3.4	66	39	59.1%	66.3	50.0
	04/28	2.3	3.4	16.0	2.8	4.0	78	50	64.1%	67.6	50.3
	04/29	1.6	3.0	11.9	2.8	3.2	75	56	74.7%	73.1	50.7
	04/30	1.9	2.9	12.3	2.4	3.8	61	50	82.0%	76.8	51.0
	05/01	1.8	2.7	8.6	2.5	3.0	111	86	77.5%	79.4	51.0
	05/02	2.0	2.7	11.5	2.4	3.3	126	85	67.5%	84.6	51.0
	05/03	1.5	2.4	9.8	2.0	2.9	98	72	73.5%	89.0	51.0
	05/04	1.6	2.1	15.9	2.0	2.2	268	213	79.5%	100.4	51.0
	05/05	1.4	2.0	17.5	1.9	2.2	447	347	77.6%	101.1	51.0
	05/06	1.3	2.0	8.6	1.6	2.4	70	58	82.9%	101.5	50.5
	05/07	1.3	2.0	10.4	1.8	2.1	306	236	77.1%	104.1	50.0
	05/08	1.4	2.5	15.2	2.1	3.0	120	89	74.2%	99.5	50.7
	05/09	1.4	2.8	6.4	2.4	3.8	52	40	76.9%	95.3	52.0
	05/10	1.7	2.7	8.3	2.5	2.8	84	65	77.4%	96.0	53.7
	05/11	1.5	2.4	5.8	1.9	2.7	60	36	60.0%	97.8	54.5
	05/12	1.4	2.3	8.7	1.8	3.1	98	48	49.0%	118.1	55.0
	05/13	1.0	1.8	9.9	1.5	1.9	327	144	44.0%	145.6	55.0
	05/14	1.1	1.5	7.1	1.3	2.5	81	26	32.1%	165.8	54.5
05/27-05/31	05/28	1.1	2.5	4.9	1.5	3.4	45	29	64.4%	139.0	56.7
06/01-06/07	06/04	1.4	2.5	5.6	2.1	2.9	27	21	77.8%	104.4	56.0
06/08-06/11	06/09	1.5	2.3	3.9	1.5	3.9	9	8	88.9%	113.3	56.5

- Detections at Lower Granite do not include tags identified on a single coil.
- Flow and temperature are averaged over the period between the median date of release and the day preceding the median date of detection at Lower Granite Dam.
- The distance from the Snake River Trap at Lewiston to Lower Granite Dam is 32.2 miles.

Table V. 1993 travel time characteristics of PIT tagged hatchery chinook released at the Salmon River (Whitebird) trap and detected at Lower Granite Dam.

Release Dates		Travel Time (days)			Confidence Limits (95%)		Number of Fish		Percent	Lower Granite	
Range	Median	Min.	Med.	Max.	Lower	Upper	Released	Detected	Detected	Flow (kcfs)	Temp. (°F)
04/11-04/12	04/12	10.5	17.9	34.4	16.5	21.3	108	41	38.0%	63.6	48.9
	04/13	9.4	19.1	31.6	15.5	20.7	97	43	44.3%	64.9	49.2
	04/14	8.9	17.9	32.6	16.8	20.4	98	36	36.7%	64.9	49.3
	04/15	8.0	18.3	30.4	14.7	20.6	103	40	38.8%	65.8	49.4
	04/16	8.4	15.2	28.7	12.6	16.9	97	45	46.4%	64.4	49.3
	04/17	6.5	13.8	26.1	12.2	16.9	100	31	31.0%	64.7	49.3
	04/18	9.6	15.1	26.6	13.7	17.5	101	40	39.6%	66.9	49.5
	04/19	5.5	13.1	21.6	12.3	14.5	103	47	45.6%	66.6	49.5
	04/20	6.5	12.5	20.4	10.5	14.1	112	36	32.1%	67.0	49.7
	04/21	7.8	13.5	22.0	11.6	15.3	99	39	39.4%	70.6	50.0
	04/22	4.9	11.1	21.5	10.3	12.5	100	40	40.0%	67.8	50.0
	04/23	7.3	12.1	28.8	10.6	13.0	99	35	35.4%	71.7	50.3
	04/24	5.5	9.8	22.3	9.2	11.2	105	40	38.1%	70.3	50.3
	04/25	5.8	9.5	18.5	8.1	10.5	100	38	38.0%	73.8	50.4
	04/26	6.3	10.1	18.8	9.0	10.6	100	38	38.0%	77.8	50.5
	04/27	7.2	9.1	15.8	8.6	10.4	100	39	39.0%	78.9	50.7
	04/28	6.6	8.5	17.5	8.2	9.9	99	26	26.3%	82.3	50.8
	04/29	3.5	9.0	22.0	7.5	10.3	101	45	44.6%	86.5	50.8
	04/30	5.3	7.2	19.3	6.7	8.6	101	43	42.6%	87.2	51.0
	05/01	4.6	8.0	12.2	6.5	9.8	102	32	31.4%	93.3	50.8
	05/02	4.2	7.1	14.3	5.9	9.6	101	34	33.7%	94.9	50.7
	05/03	3.1	8.0	18.8	5.6	11.7	100	34	34.0%	97.8	50.8
	05/04	3.4	7.2	16.8	6.1	9.4	100	36	36.0%	100.3	50.7
	05/05	4.5	9.0	15.7	8.1	9.8	100	34	34.0%	103.6	52.0
	05/06	4.7	9.7	19.1	8.4	10.5	99	31	31.3%	116.1	52.6
	05/07	5.8	7.7	34.0	7.4	10.5	97	22	22.7%	111.1	52.6
	05/08	5.6	7.7	19.9	7.4	8.6	100	30	30.0%	119.8	53.1
	05/09	4.7	6.4	16.2	5.6	7.1	101	29	28.7%	113.4	53.5
	05/10	3.8	5.7	11.7	5.4	6.5	98	28	28.6%	125.4	54.2
	05/11	3.3	4.6	18.2	3.9	6.8	99	25	25.3%	132.0	54.6
	05/12	2.2	4.8	16.2	3.9	9.5	98	36	36.7%	149.7	54.6

- Detections at Lower Granite do not include tags identified on a single coil.
- Flow and temperature are averaged over the period between the median date of release and the day preceding the median date of detection at Lower Granite Dam.
- The distance from the Salmon River Trap at Whitebird to Lower Granite Dam is 133.7 miles.

Table VI. 1993 travel time characteristics of PIT tagged wild chinook released at the Salmon River (Whitebird) trap and detected at Lower Granite Dam.

Release Dates		Travel Time (days)			Confidence Limits (95%)		Number of Fish		Percent	Lower Granite Flow	Lower Granite Temp.
Range	Median	Min.	Med.	Max.	Lower	Upper	Released	Detected	Detected	(kcfs)	(°F)
03/26-03/27	03/27	21.3	28.7	36.6	24.5	30.4	51	22	43.1%	69.4	47.0
03/28-03/29	03/29	18.8	27.1	33.6	25.6	28.1	72	30	41.7%	67.8	47.3
	03/30	15.7	26.5	37.3	23.9	29.8	50	26	52.0%	67.1	47.5
	03/31	16.2	24.6	34.4	22.3	25.5	51	26	51.0%	66.9	47.6
	04/01	15.0	23.5	31.8	21.6	24.9	44	23	52.3%	66.8	47.7
04/02-04/03	04/02	12.5	21.3	34.4	19.7	23.8	47	26	55.3%	67.5	47.6
04/04-04/05	04/05	10.5	20.1	31.4	17.6	22.0	51	30	58.8%	67.2	47.9
	04/06	9.2	17.3	27.5	15.6	20.7	50	32	64.0%	67.0	47.8
	04/07	11.2	17.2	22.4	15.6	18.1	50	27	54.0%	65.1	47.9
	04/08	6.8	14.6	29.1	13.8	16.3	50	30	60.0%	64.5	47.9
	04/09	9.2	16.0	25.8	13.3	19.2	50	27	54.0%	63.9	48.3
	04/10	8.5	13.8	22.1	12.5	15.4	50	23	46.0%	63.6	48.2
	04/11	10.4	13.4	28.8	12.2	15.1	49	27	55.1%	63.2	48.3
	04/12	9.7	13.5	22.6	11.8	15.6	56	32	57.1%	62.7	48.6
	04/13	8.6	12.1	18.4	10.6	12.7	51	27	52.9%	62.4	48.7
	04/14	8.3	12.7	25.5	11.5	15.5	51	29	56.9%	62.7	48.9
	04/15	7.9	11.4	18.5	10.4	13.5	49	31	63.3%	62.5	48.9
	04/16	7.5	13.0	28.6	10.9	13.8	50	30	60.0%	63.7	49.1
04/17-04/18	04/18	6.6	11.6	21.8	10.0	14.5	84	39	46.4%	64.4	49.2
	04/19	6.5	10.5	20.5	9.5	13.3	54	29	53.7%	64.7	49.2
	04/20	6.3	10.1	16.7	9.6	11.4	50	30	60.0%	64.1	49.3
	04/21	7.2	10.1	21.1	8.3	12.0	47	23	48.9%	65.2	49.6
04/22-04/23	04/23	5.7	9.0	19.8	8.4	10.5	71	36	50.7%	67.5	50.0
	04/24	5.5	8.7	24.7	8.0	9.9	50	30	60.0%	69.2	50.2
	04/25	5.9	8.5	12.6	7.4	10.4	45	18	40.0%	71.1	50.3
	04/26	5.1	8.2	20.2	7.1	10.2	50	24	48.0%	72.2	50.4
	04/27	6.0	8.5	17.9	7.4	9.6	50	22	44.0%	78.9	50.7
	04/28	5.5	8.0	15.8	7.5	9.5	50	24	48.0%	80.2	50.8
	04/29	4.5	7.4	18.5	7.1	9.4	45	31	68.9%	82.3	50.9
	04/30	5.3	6.9	13.1	6.2	7.9	41	22	53.7%	87.2	51.0
	05/01	4.8	6.9	18.2	5.6	8.4	50	24	48.0%	91.7	50.9
	05/02	4.0	5.4	9.2	4.5	6.4	49	24	49.0%	91.2	51.0
	05/03	3.4	5.5	11.8	4.5	6.5	49	26	53.1%	98.1	50.7
	05/04	3.8	7.1	26.0	5.4	9.9	50	22	44.0%	100.3	50.7
	05/05	4.6	8.5	12.6	6.9	9.8	49	2 5	51.0%	103.6	52.0
	05/06	4.7	7.3	12.5	6.3	8.5	51	26	51.0%	99.6	51.7
)5/07-05/08	05/07	4.6	7.6	12.7	6.8	8.3	102	34	33.3%	111.1	52.6
)5/09-05/10	05/10	4.4	6.4	11.7	5.5	7.8	99	33	33.3%	125.4	54.2
)5/11-05/12	05111	2.5	4.6	11.8	4.1	5.3	too	37	37.0%	132.0	54.6

- Detections at Lower Granite do not include tags identified on a single coil.
- Flow and temperature are averaged over the period between the median date of release and the day preceding the median date of detection at Lower Granite Dam.
- The distance from the Salmon River Trap at Whitebird to Lower Granite Dam is 133.7 miles.

Table VII. 1993 travel time characteristics of PIT tagged steelhead released at the Salmon River (Whitebird) trap and detected at Lower Granite Dam.

Release Dates Range	Median	Travel Time (days) Min.	Med.	Max.	Confidence Limits (95%) Lower	Upper	Number of Fish Released	Detected	Percent Detected	Lower Granite Flow (kcfs)	Temp (°F)
					Hatchery Steelhead						
	04/15	3.6	12.6	31.6	9.1	17.1	57	47	82.5%	63.4	49.(
	04/16	4.3	11.1	32.5	8.8	14.5	60	21	70.0%	63.1	48.5
	04/17	5.1	13.9	23.1	9.0	17.8	29	38	72.4%	64.7	49.3
	04/18	4.2	12.8	28.2	7.1	18.5	53		71.7%	65.0	49.:
	04/19	4.5	8.7	27.9	7.3	12.7	60	47	78.3%	64.5	49.c
	04/20	3.8	8.9	30.0	7.1	10.1	60	48	80.0%	64.0	49.1
	04/21	3.6	7.7	36.6	6.4	9.1	65	S0	76.9%	64.3	49.4
	04/22	3.6	6.8	22.1	5.7	12.4	61	51	83.6%	64.3	49.t
	04/23	3.6	9.3	35.5	7.6		61	47	77.1%	67.5	5o.c
	04/24	3.5	8.8	27.1	7.2	11.8	65	53	81.5%	69.2	50.2
	04/25	3.4	7.1	24.4	5.6	11.1	60	46	74.2%	69.1	50.1
	04/26	3.9	7.9	21.2	6.2	10.2	60	34	56.7%	72.2	50.4
	04/27	3.8	9.0	25.5	6.2	10.4	61	43	71.7%	78.9	50.7
	04128	3.9	7.0	25.4	5.2	8.2	60	47	77.1%	77.0	50.7
	04/29	3.2	5.2	24.8	4.3	7.4		41	68.3%	75.0	50.8
	04/30	3.2	5.2	18.6	3.9	7.4	45	34	75.6%	81.7	51.a
	05/01	3.5	5.2	23.0	4.7	5.9	60	48	80.0%	87.8	51.0
	05/02	2.7	4.4	14.5	4.1	4.8	58	45	77.6%	89.1	51.a
	05/03	2.8	3.4	20.0	3.1	3.7	61	47	77.1%	93.6	51.0
	05/04	2.5	3.7	21.6	3.2	5.1	60	48	80.0%	100.9	50.8
	05/05	2.5	4.6	22.5	3.2	6.9	60	46	76.7%	102.3	so.4
	05/06	2.5	4.3	15.7	3.3	6.8	59	48	81.4%	102.2	50.3
	05/07	2.3	4.1	12.9	3.1	5.7	59	47	77.1%	100.5	50.5
	05/08	2.8	4.8	15.3	3.9	6.1	61	39	66.1%	98.8	52.2
	05/09	2.7	5.3	13.9	5.0	6.0		41	67.2%	104.4	53.2
	05/10	2.6	4.7	21.1	4.4	5.7	60	36	60.0%	115.9	54.2
	05/11	2.6	4.4	16.0	3.2	5.3	60	33	55.0%	121.7	54.8
	05/12	2.2	3.0	14.1	2.8	3.3	60	26	43.3%	131.6	55.0
					Wild Steelhead						
03/30-04/09	04/08	16.4	22.7	34.8	n/a	n/a	15	4	26.7%	64.9	48.6
04/10-04/14	04/13	5.2	12.9	26.3	8.4	25.3	21	12	57.1%	62.4	48.8
04/15-04/20	04/19	4.2	6.8	29.4	5.4	10.7	30	19	63.3%	63.4	48.9
04/21-04/25	04/23	3.7	5.4	12.1	4.8	6.5	41	29	70.7%	64.4	49.6
04/26-04/30	04128	3.6	5.1	10.4	4.6	6.4	47	37	78.7%	72.2	50.6
	05/01	3.9	5.2	12.1	4.7	9.1	25	14	56.0%	87.8	51.0
	05/02	2.7	4.1	7.2	3.6	6.9	23	13	56.5%	89.1	51.0
	05103	2.6	3.3	6.2	3.2	4.3	32	34	81.3%	93.6	51.0
	05/04	2.4	3.2	9.2	2.6	4.1	42	88	81.0%	100.1	51.0
	05/05	2.1	3.4	11.1	3.2	3.7	128		68.8%	101.9	50.7
	05/06	2.3	3.4	10.3	3.2	3.6	186	126	67.7%	102.6	50.3
	05/07	2.6	4.4	10.4	3.8	5.0	77	47	61.0%	100.5	50.5
	05/08	2.6	4.5	9.0	4.3	5.3	65	46	70.8%	98.8	52.2
	05/09	3.0	5.2	9.5	4.1	6.6	47	24	51.1%	104.4	53.2
	05/10	2.8	4.2	5.2	3.7	4.7	37	16	43.2%	105.2	54.0
	05111	2.5	3.3	9.4	3.0	4.1	32	15	46.9%	109.4	54.7
	05/12	2.1	2.6	7.9	2.4	4.6	57	19	33.3%	131.6	55.0

- Detections at Lower Granite do not include tags identified on a single coil.
- Flow and temperature are averaged over the period between the median date of release and the day preceding the median date of detection at Lower Granite Dam.
- The distance from the Salmon River Trap at Whitebird to Lower Granite Dam is 133.7 miles.

Table **VIII.** 1993 travel time characteristics of PIT tagged fish released at Rock Island Dam and detected at McNary Dam.

Release Dates Range	Median	Travel Time (days) Min.	Med.	Max.	Confidence Limits (95%) Lower	Upper	Number of Fish Released	Detected	Percent Detected	Priest Rapids Flow #1 (kcfs)	Flow #2 (kcfs)	Temp. (°F)
					Spring Chinook							
04126-04127	04127	10.7	16.7	42.6	14.7	21.6	201	39	19.4%	89.3	102.0	41.6
04/28-04/29	04/28	8.4	15.1	48.9	12.6	19.5	200	32	16.0%	89.3	102.4	47.6
04/30-05/05	05/02	8.3	14.1	58.0	11.3	21.0	278	35	12.6%	110.0	116.4	48.2
05/06-05/08	05/07	8.7	12.6	33.4	12.1	14.1	208	25	12.0%	135.5	154.1	49.2
05/09-05/10	05/10	7.4	10.6	35.2	9.4	15.9	194	24	12.4%	160.1	169.6	50.0
05/11-05/12	05/11	5.5	11.2	48.0	9.2	14.1	200	32	16.0%	168.8	175.2	50.4
05/13-05/14	05113	5.6	10.4	46.7	8.9	12.3	199	33	16.6%	183.4	182.8	50.9
05/15-05/16	05/16	5.7	9.2	45.2	8.1	12.0	197	29	14.7%	200.5	200.5	51.2
05/17-05/18	05/17	5.0	9.3	40.6	8.2	11.0	199	40	20.1%	199.9	199.0	51.6
05/19-05/20	05/20	4.8	12.4	63.7	9.3	14.1	199	42	21.1%	193.2	178.8	52.6
05/21-05/22	05/21	6.0	18.8	45.9	12.8	33.1	200	49	24.5%	163.3	164.3	53.4
05/23-05/24	05/23	8.9	17.1	73.5	11.8	34.2	200	34	17.0%	156.5	159.9	53.6
05/25-05/26	05126	9.5	27.8	52.7	16.9	33.7	198	33	16.7%	146.9	129.4	56.0
05/27-05/29	05/28	9.7	28.0	37.6	26.0	29.2	217	21	9.7%	137.0	125.1	56.6
					Summer Chinook							
06/2 l-06125	06/23	7.3	37.5	96.0	15.3	57.4	600	21	3.5%	115.4	113.9	62.3
06/28-07/02	07/01	7.8	18.9	90.1	17.9	30.7	600	44	7.3%	1 15.8	118.2	62.0
07/06-07/09	07/07	8.3	26.7	71.0	14.9	41.0	351	22	6.3%	116.4	108.8	63.3
07/12-07/16	07114	11.5	32.7	86.8	15.2	42.5	373	22	5.9%	106.3	100.2	65.2
07/19-07/23	07/21	9.0	22.2	79.7	15.7	27.2	889	65	7.3%	103.7	97.4	65.5
07/26-07/30	07/28	8.7	23.1	92.9	20.7	30.7	826	54	6.5%	89.0	91.5	66.7
08/02-08/06	08/04	11.0	25.0	84.9	13.2	40.8	347	12	3.5%	92.1	83.9	67.2
08/09-08/13	08/11	10.5	38.2	62.3	10.5	62.3	234	8	3.4%	81.6	79.5	67.0
					Hatche Steelhead							
04/23-04/24	04/23	10.5	16.4	24.9	12.5	7 7.9	83	16	19.3%	72.5	80.1	47.3
05/03-05/08	05/06	6.5	8.8	17.7	7.8	10.9	405	21	5.2%	126.8	130.0	48.1
05/09-05/14	05/11	5.1	7.4	18.4	6.5	9.4	419	18	4.3%	160.1	160.1	49.6
05/15-05/18	05/17	3.5	6.9	15.2	6.2	9.8	279	26	9.3%	200.5	199.9	51.3
0511945122	05/20	4.3	6.0	24.9	5.8	7.4	179	23	12.8%	199.2	199.4	51.8
05/23-05/26	05/24	4.3	7.8	26.3	5.4	11.4	77	12	15.6%	170.7	167.6	53.1
05/27-05/29	05/28	5.4	9.3	14.1	5.4	13.8	52	10	19.2%	153.3	153.4	53.7
					Wild Steelhead							
04123-04124	04/23	11.9	12.7	13.5	n/a	n/a	6	2	33.3%	71.5	71.9	47.2
05/03-05/08	05/06	6.3	7.5	9.0	6.8	8.8	139	12	8.6%	126.8	128.6	47.9
05/09-05/14	05111	5.2	7.5	10.9	6.4	9.4	180	9	5.0%	160.1	165.5	49.8
05/15-05/18	05/16	4.4	6.5	7.9	4.8	7.7	122	15	12.3%	192.9	200.5	51.3
05/19-05/22	05/21	4.5	6.9	11.0	6.0	7.7	140	21	15.0%	197.6	193.2	52.1
05/23-05/26	05/24	4.9	7.1	19.7	5.9	8.2	140	21	15.0%	178.3	170.7	53.0
05/27-05/29	05/28	6.3	8.2	13.2	7.0	9.1	91	19	20.9%	153.3	154.4	53.4
					Sockeye ll)							
	04/20	13.9	17.2	33.8	16.1	18.6	100	15	15.0%	60.0	71.6	47.1
	04/21	12.4	15.9	28.9	15.6	16.4	168	37	22.0%	11.5	72.5	41.2
	04/22	12.9	14.7	21.1	14.6	15.7	100	27	27.0%	71.5	73.5	47.3
04/23-04/24	04/23	11.4	14.7	29.9	13.8	18.3	156	22	14.1%	72.0	77.0	41.3
	04/26	9.7	11.6	30.7	11.2	13.5	150	28	18.7%	75.5	82.0	47.5
	04127	9.4	12.6	46.4	11.4	15.4	149	27	18.1%	79.6	88.6	47.4
	04/28	8.9	11.2	43.9	10.3	12.2	150	29	19.3%	84.4	90.5	47.5
	04129	8.8	11.3	22.5	10.3	15.3	150	22	14.7%	89.3	94.3	47.5
04130-05101	04130	8.3	13.4	36.2	10.8	18.5	185	27	14.6%	94.8	107.8	47.7
05/02-05/06	05/03	8.3	15.8	53.2	12.9	18.3	340	32	9.4%	126.8	135.7	48.6
05/07-05/11	05/09	4.8	9.2	30.3	7.3	12.6	363	27	7.4%	137.9	151.8	49.1
05/12-05/14	05/13	3.9	6.3	28.8	5.1	8.9	300	23	7.7%	168.8	171.4	50.2
05/15-05/17	05116	3.6	4.9	19.0	4.2	6.1	‘97	32	10.8%	192.9	200.0	51.0
05/18-05/19	05/18	3.9	5.5	20.8	4.7	6.9	202	30	14.9%	199.9	201.0	51.5
05/20-05/21	05/20	3.8	5.6	13.1	5.1	6.7	201	26	12.9%	199.2	199.4	51.8
05/22-05/23	05/22	3.7	7.4	16.1	6.1	8.1	300	37	18.5%	184.5	184.5	52.4
	05/24	5.2	8.0	20.8	7.0	11.8	100	27	27.0;	170.7	167.6	53.1
05/25-05/26	05125	5.2	8.4	17.4	7.2	11.3	182	30	16.5%	163.3	161.2	53.4
05/27-05/29	**05128**	**5.4**	**10.6**	**34.0**	8.2	12.4	**206**	38	18.4%	I 155.5	148.3	54.2

- Detections at McNary include tags identified on a single coil.
- Flow #1 is averaged at Priest Rapids Dam over the seven day period around the estimated median date of passage.
- Flow #2 is avereged at Priest Rapids Dam over the period from the median date of release thorugh the day preceding the date of median detection at McNary Dam.
- The distance from Rock Island Dam to McNary Dam is 161.4 miles

Table IX. 1993 travel time characteristics of PIT tagged fish released at Little Goose Dam and detected at McNary Dam.

Release Dates Range	Median	Travel Time (days) Min.	Med.	Max.	Confidence Limits (95%) Lower	Upper	Number of Fish Released	Detected	Percent Detected	Ice Harbor Flow #1 (kcfs)	Flow #2 (kcfs)	Temp. (°F)
					Hatchery Chinook							
	04/26	6.9	9.5	12.9	8.6	10.1	78	40	51.3%	85.0	80.9	51.6
	04/27	6.7	8.7	14.9	8.3	9.7	110	55	50.0%	85.0	82.1	51.7
	04128	6.0	7.7	12.0	7.4	8.3	111	48	43.2%	90.4	83.4	51.8
	04/29	5.4	7.0	9.4	6.7	7.7	90	46	51.1%	90.4	85.0	51.9
	04130	5.5	6.9	11.2	6.7	7.2	100	39	39.0%	96.0	90.4	52.1
	05/01	5.5	6.5	9.6	6.2	7.8	98	15	15.3%	98.9	96.0	52.4
	05/02	4.5	6.7	8.6	5.3	7.6	114	18	15.8%	102.1	98.9	52.6
	05/03	5.5	6.9	8.7	6.1	7.6	89	19	21.4%	104.1	102.1	52.7
	05/04	4.5	6.0	9.8	5.0	7.4	103	22	21.4%	104.1	105.4	52.8
	05105	4.1	6.4	9.6	5.7	7.3	99	26	26.3%	103.3	105.3	53.0
	05/09	3.6	4.7	6.6	4.4	5.4	100	16	16.0%	120.5	106.2	53.0
05/10-5/12	05111	3.8	5.6	7.9	4.1	6.6	290	14	4.8%	139.4	135.5	53.2
	05/13	3.7	4.6	9.2	4.5	4.8	855	98	11.5%	157.1	155.2	53.4
	05/15	3.4	4.1	8.3	3.6	4.8	54	10	18.5%	163.5	164.3	53.8
	05116	3.8	4.4	10.3	3.9	5.1	68	12	17.7%	165.1	164.5	54.3
	05/17	3.4	4.3	8.6	3.7	5.3	115	17	14.8%	164.4	165.2	55.0
	05/18	3.5	4.9	6.6	4.3	6.2	88	12	13.6%	161.7	164.3	55.2
	05119	3.7	5.7	7.8	4.3	7.1	103	11	10.7%	156.1	161.4	55.7
	05/20	3.8	5.9	11.5	5.7	6.6	90	20	22.2%	150.0	155.4	55.8
05/21-5/22	05/21	3.8	5.7	8.7	5.2	6.8	85	23	27.1%	146.2	146.1	55.7
	05/23	4.5	6.8	9.8	5.8	8.6	38	14	36.8%	136.3	139.6	56.3
05/24-5/25	05/24	4.8	7.3	12.4	6.3	7.7	74	18	24.3%	133.4	136.3	56.4
	05/26	4.6	6.7	9.5	5.5	8.3	114	16	14.0%	134.3	132.4	56.7
	05/27	5.3	6.5	11.6	5.7	7.7	119	17	14.3%	129.5	134.3	57.0
	05/28	4.3	5.8	9.7	4.7	8.5	122	11	9.0%	129.5	132.1	57.2
					Hatchery Steelhead							
	04/30	4.4	6.0	7.9	5.4	7.0	60	23	38.3%	96.0	87.8	52.0
	05/01	4.9	5.5	8.5	5.2	6.1	70	15	21.4%	96.0	94.1	52.3
05/02-05/03	05/02	3.7	5.6	10.8	4.5	8.9	155	13	8.4%	98.9	97.4	52.5
	05/04	3.4	8.0	11.7	4.4	10.0	93	9	9.7%	103.3	103.2	52.9
	05/05	3.8	6.9	11.9	5.2	8.3	79	11	13.9%	103.3	104.1	53.0
05/06-05/07	05/06	3.3	5.5	10.8	4.7	6.5	133	22	16.5%	103.3	103.3	53.0
05/08-05/12	05/10	4.1	5.7	7.9	4.6	6.8	349	17	4.9%	129.9	123.1	53.0
05-13-05116	05/15	3.3	4.9	11.6	3.4	5.6	289	13	4.5%	165.5	163.5	54.0
05/17-05/19	05/18	3.0	3.7	6.4	3.5	5.5	192	16	8.3%	164.4	166.3	55.3
05/20-05/21	05121	3.2	4.7	8.1	3.6	6.7	13.5	13	9.6%	146.2	151.7	55.6
	05/22	3.0	4.5	10.1	3.7	6.4	82	17	20.7 %	141.6	141.8	55.8
	05/23	3.1	4.6	8.7	1.4	6.5	59	1'	20.3%	139.6	139.9	56.0
	05/24	3.6	5.1	6.4	3.8	5.7	63	ii	17.5%	136.3	133.7	56.2
	05/25	3.3	4.3	8.8	3.0	5.9	87	19	21.8%	133.4	131.0	56.3
05/26-05/28	05127	3.3	1.7	7.7	3.9	5.3	201	12	6.0%	134.3	138.3	56.8
					Wild Stee ead							
	04/26	5.2	7.2	9.7	6.6	7.9	38	21	57.9%	76.2	74.5	51.3
	04/27	4.7	7.3	14.3	6.6	7.7	38	22	65.9%	19.7 85.0	76.2 79.7	51.6 51.4
	04128	5.5	6.6	24.3	6.4	7.3	44	29	[illegible]			
	04129	5.0	6.0	7.5	5.4	6.4	36	25	69.4%	90.4	81.0	51.7
	04/30	4.7	5.6	6.8	5.1	6.4	29	15	51.7%	90.4	87.8	52.0
	05/01	4.2	4.7	6.7	4.4	5.4	35	15	42.9%	96.0	91.8	52.2
05/02-05/06	05/04	4.1	5.5	7.4	1.7	6.0	111	14	12.6%	104.1	105.4	52.8
05/07-05/12	05109	3.5	4.6	6.9	1.5	5.5	193	18	9.3%	120.5	106.2	53.0
05/13-05/18	05115	1.6	3.3	5.0	3.0	4.4	191	15	7.9%	163.5	164.6	53.7
05/19-05/20	05120	2.7	3.4	6.4	3.0	4.5	80	14	17.5%	156.1	165.9	55.7
05/21-05/24	05123	'1.5	3.5	6.5	3.3	5.3	122	15	12.3%	139.6	139.9	56.0
05/25-05/28	05127	3.2	4.2	9.7	3.7	5.4	149	13	8.7%	132.4	141.9	56.8

- Detections at McNary include tags Identified on a single coil.
- Flow #1 is averaged at Ice Harbor Dam over the seven day period around the estimated median date of passage.
- Flow #2 is averaged at Ice Harbor Dam over the period from the median date of release thorugh the day preceding the date of median detection at McNary Dam.
- The distance from Little Goose Dam to McNary Dam is 102.6 miles.
- Chinook tagged by NMFS were released into the bypass outfall on May 13. All other fish were marked as part of the SMP.

Table X. 1993 travel time characteristics of PIT tagged chinook released at Dworshak NFH and detected at Lower Granite Dam.

Raceway	Release Date	Travel Time (days) Min.	Med.	Max.	Confidence Limits (95%) Lower	Upper	Number of Fish Released	Detected	Percent Detected	Lower Granite Flow (kcfs)	Temp. (°F)
					Early Group Release						
1	04/08	7.9	28.9	77.8	24.7	32.4	244	54	22.1%	100.3	50.7
4	04/08	5.5	23.8	63.6	22.9	26.5	252	68	27.0%	82.3	50.9
16	04108	5.5	25.2	54.2	22.3	27.6	250	66	26.4%	87.2	51.0
19	04/08	7.7	23.8	39.2	22.6	24.9	248	79	31.9%	82.3	50.9
	04/08	**5.5**	**24.8**	**77.8**	**23.6**	**25.9**	**994**	**267**	**26.9%**	**87.2**	**51.0**
					Middle Group Release						
12	04/22	5.6	12.6	23.6	11.6	14.1	248	83	33.5%	94.9	50.7
13	04/22	4.6	13.8	42.1	12.6	15.2	249	71	28.5%	98.5	50.6
15	04/22	6.8	13.7	23.8	12.5	15.3	250	85	34.0%	100.3	50.7
25	04/22	6.5	15.1	37.6	14.3	16.8	245	87	35.5%	98.5	50.6
	04/22	**4.6**	**14.1**	**42.1**	**13.4**	**14.4**	**992**	**326**	**32.9%**	**98.5**	**50.6**
					Late Group Release						
5	05/06	2.9	9.6	27.6	8.5	11.6	252	67	26.6%	166.8	54.1
8	05/06	2.6	10.2	34.3	8.8	12.8	250	62	24.8%	166.8	54.1
20	05/06	4.4	10.1	25.8	9.2	11.3	234	68	29.1%	166.8	54.1
23	05/06	2.9	9.9	87.5	9.4	12.1	247	77	31.2%	166.8	54.1
	05/06	**2.6**	**9.9**	**87.5**	**9.5**	**10.5**	**983**	**274**	**27.9%**	**166.8**	**54.1**

- Detections at Lower Granite do not include tags identified on a single coil.
- Flow and temperature arc averaged over the seven day period around the median detection date.
- The distance from Dworshak NFH to Lower Granite Dam is 73.1 miles.

Table XI. 1993 travel time characteristics of PIT tagged steelhead released at Dworshak NFH and detected at Lower Granite Dam.

Raceway	Release Date	Travel Time (days) Min.	Med.	Max.	Confidence Limit.5 (95%) Lower	Upper	Number of Fish Released	Detected	Percent Detected	Lower Granite Flow (kcfs)	Temp. (°F)
					Water Svstem #1						
11	05/03	2.0	4.8	24.3	4.3	1.4	249	161	64.7%	99.4	51.1
39	05/03	1.9	4.6	22.5	3.7	5.6	245	157	64.1%	99.4	51.1
	05/03	**1.9**	**4.7**	**24.3**	**4.2**	**5.2**	**494**	**318**	**64.4%**	**99.4**	**51.1**
					Water System #2						
44	05/03	1.9	3.4	24.5	3.3	3.8	249	191	76.7%	98.5	50.6
8	05/03	1.7	3.4	18.9	3.3	3.7	250	141	56.4%	98.5	SO.6
	05/03	**1.7**	**3.4**	**24.5**	**3.4**	**3.7**	**499**	**332**	**66.5%**	**98.5**	**50.6**
					Water System #3						
55	05/04	1.9	4.2	30.3	3.4	5.0	250	195	78.0%	99.4	51.1
66	05/04	1.9	3.9	22.4	3.4	4.2	250	194	77.6%	99.4	51.1
	05/04	**1.9**	**4.0**	**30.3**	**3.5**	**4.3**	**500**	**389**	**77.8%**	**99.4**	**51.1**

- Detections at Lower Granite do not include tags identified on a single coil.
- Flow and temperature are averaged over the seven day period around the median detection date
- The distance from Dworshak NFH to Lower Granite Dam is 73.1 miles.

Table XII. 1993 travel time characteristics of PIT tagged chinook released from McCall and Rapid River hatcheries. and detected at Lower Granite Dam.

Tagging Method	Release Date	Travel Time (days) Min.	Med.	Max.	Confidence Limits (95%) Lower	Upper	Number of Fish Released	Detected	Percent Detected	Lower Granite Flow (kcfs)	Temp. (°F)
					Rapid River Hatchery						
Hand	04/17	6.9	16.7	30.9	16.4	17.4	1506	493	32.7%	91.7	50.9
Auto	04/17	8.7	16.6	33.6	16.4	17.2	1479	481	32.5 %	91.7	50.9
	04/17	**6.9**	**16.7**	**33.6**	**16.4**	**17.1**	**2985**	**974**	**32.6%**	**91.7**	**50.9**
					McCall Hatchery						
Hand	04/03	23.0	40.7	85.4	39.4	[illegible]	1495	340	22.7%	145.2	54.3
Auto	04/03	21.8	41.3	79.8	40.1	43.1	1498	338	22.6%	145.2	54.3
	04/03	**21.8**	**41.0**	**85.4**	**40.1**	**41.6**	**2993**	**678**	**22.7%**	**145.2**	**54.3**

- Detections at Lower Granite do not include tags identified on a single coil.
- Flow and temperature are averaged over the seven day period around the median detection date.
- Fish reared at Rapid River Hatchery were released on-site. The distance from Rapid River Hatchery to Lower Granite Dam is 173.6 miles. Fish reared at McCall Hatchery were released into the South Fork Salmon River at Knox Bridge. The distance from Knox Bridge to Lower Granite Dam is approximately 283 miles.
- Tagging method refers to either the manual insertion of tags using individual syringes (hand), or the use of an electro-mechanical tagging machine (auto).

Table XIII. 1993 travel time characteristics of PIT tagged chinook released at Lookingglass Hatchery and detected at Lower Granite Dam.

Raceway	Release Date	Travel Time (days) Min.	Med.	Max.	Confidence Limits (95%) Lower	Upper	Number of Fish Released	Detected	Percent Detected	Lower Granite Flow (kcfs)	Temp. (°F)
					Low Density Rearing						
9	04/07	6.9	21.5	36.8	20.7	22.5	499	181	36.3%	71.1	50.3
10	04/07	6.7	21.0	33.7	20.4	22.0	497	165	33.2%	69.1	50.1
	04/07	**6.7**	**21.4**	**36.8**	**20.8**	**22.0**	**996**	**346**	**34.7%**	**69.1**	**50.1**
					Normal Density Rearing						
11	04/07	7.9	20.9	36.4	19.4	21.7	499	147	29.5%	69.1	50.1
12	04/07	7.4	18.8	33.7	17.6	20.0	498	169	33.9%	64.7	49.7
	04/07	**7.4**	**19.6**	**36.4**	**18.8**	**20.9**	**997**	**316**	**31.7%**	**66.4**	**50.0**
					Total						
	04/07	**6.7**	**20.8**	**36.8**	**20.3**	**21.4**	**1993**	**662**	**33.2%**	**69.1**	**50.1**

- Detections at Lower Granite do not include tags identified on a single coil.
- Flow and temperature are averaged over the seven day period around the median detection date.
- The distance from Lookingglass Hatchery to Lower Granite Dam is 147.2 miles.

Table XN. 1993 travel time characteristics of PIT tagged wild fall chinook released in the Hanford Reach and detected at McNary Dam.

Release Date	Travel Time (days) Min.	Med.	Max.	Confidence Limits (95%) Lower	Upper	Number of Fish Released	Detected	Percent Detected	Priest Rapids Flow (kcfs)	Temp. (°F)
06/07	4.7	27.4	60.6	24.0	28.9	309	61	19.7%	132.4	55.5
06/08	5.8	28.9	71.9	27.8	30.2	1112	190	17.1%	135.9	55.0
06/09	3.2	29.8	78.9	28.9	30.9	1524	300	19.7%	132.9	55.8
06/09	3.2	29.0	78.9	28.4	29.9	2945	551	18.7%	132.9	55.8

- Detections at McNary include tags identified on a single coil.
- Flow and temperature are averaged at Priest Rapids over the four day period including and subsequent to the date of release.
- The distance from the release point in the Hanford Reach to McNary Dam is 75.0 miles.

Table XV. 1993 travel time characteristics of PIT tagged chinook released at mid-Columbia hatcheries and detected at McNary Dam.

Tagging Group	Release Date	Travel Time (days) Min.	Med.	Max.	Confidence Limits (95%) Lower	Upper	Number of Fish Released	Detected	Percent Detected	Priest Rapids Flow (kcfs)	Temp. (°F)
Entiat Spring Chinook											
	04/01	21.2	36.4	86.9	35.3	38.0	1192	101	8.5%	56.6	45.5
Leavenworth Spring Chinook											
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	397	49	12.3 %	100.3	47.3
							402	57	14.2%	89.3	47.7
Rwy 4 1	04/22	11.0	21.0	57.7	17.8	28.1	393	52	13.2%	84.4	47.6
	04/22	10.7	25.5	63.5	21.4	28.6	1192	158	13.3%	85.5	47.6
Winthrop Spring Chinook											
Rwy D 1 2	04/15	18.4	29.6	71.1	26.0	34.3	505	41	8.1%	85.5	47.6
Rwy Cl0	04/15	20.3	28.4	64.8	25.4	31.9	498	43	8.6%	89.3	47.7
Rwy D15	04/15	23.4	33.1	71.0	28.9	35.3	486	38	7.8%	100.3	47.3
	04/15	18.4	29.4	71.1	28.4	33.2	1489	122	8.2%	89.3	47.7
Wells Summer Chinook											
Small Pond	04/19	20.0	32.7	70.8	27.8	34.6	519	49	9.4%	100.3	47.3
Large Pond	04/19	14.2	25.6	64.0	24.1	29.7	959	78	8.1%	89.3	47.7
	04/19	14.2	28.0	70.8	25.3	32.1	1478	127	8.6%	85.5	47.6
Turtle Rock Fall Chinook											
Group 1	06/30	10.4	20.0	59.3	18.3	30.8	767	42	5.5%	116.6	61.9
Group 2	06/30	9.5	30.9	51.2	21.9	35.8	7 2 8	41	5.6%	113.2	62.4
Group 3	06/30	12.2	25.3	66.3	20.0	34.9	788	46	5.8%	111.2	62.4
Group 4	06/30	13.2	28.0	82.3	19.3	36.6	717	33	4.6%	112.0	62.4
	06/30	9.5	26.6	82.3	22.0	31.0	3000	162	5.4%	111.2	62.4

- Detections at McNary include tags identified on a single coil.
- Flow and temperature are averaged at Priest Rapids Dam over the seven day period around the estimated median date of passage.
- The distances from release sites to McNary Dam are: Winthrop NFH — 282 miles: Wells Hatchery — 223 Turtle Rock Hatchery — 183 miles: Leavenworth NFH — 205: Entiat NFH — 202 miles.

Table XVI. Travel time of freeze branded yearling **chinook** hatchery smolts from release to Lower Granite Dam, 1993.

Brand	Release Site	Release Number	Release Date	Passage Index	Code	Med. Recap. Date	Travel Time (days)	Flow (kcfs)	Miles to LGR	Speed (miles/day)
Imnaba River **Drainage**										
LA-A-2	IMNAHA H	20.271	04/12	5.505	C	05104	22	88.6	133.8	6.1
RA-A-2	IMNAHA H	20.384	04/12	7.490	C	05/06	24	95.9	133.8	5.6
LA-A-4	IMNAHA H	20.385	04/12!	5.793	C	05/05	23	92.5	133.8	5.8
RA-A-4	IMNAHA H	20.094	04/12	4.366	C	05/03	21	83.5	133.8	6.4
GrandeRonde Rivet Drainage										
LA-A-I	LOOKINGGLASSH	20,695	04107	7.168	B	04129	22	69.6	148.6	6.8
LA-A-3	LOOKINGGLASSH	20.541	04/07	5.711	B	04/27	20	65.2	148.6	7.4
RA-A-1	LOOKINGGLASSH	20,537	04107	7,340	B	04/28	21	67.3	148.6	7.1
RA-A-3	LOOKINGGLASSH	20.047	04/07	5.390	B	04/27	20	65.2	148.6	7.4

Table XW. Travel time of freeze branded steelhead hatchery smolts from release to Lower Granite Dam, 1993.

Brand	Release Site	Release Nmnber	Release Date		Passage Index	Code	Med. Recap. Date	Travel Time (days)	Flow (kcfs)	Miles to LGR	speed (miles/day)
Clearwater River Drainage											
RA-R-2	SFCLEARWATERR	21,000	04121	*	11.376	B	05/02	11	78.4	110.5	10.0
LD-R-1	DWORSHAKH	10,000	05/04	*	5.386	C	05109	5	99.3	73.1	14.6
LD-R-3	DWORSHAKH	10,000	05/04	*	6.283	C	05/08	4	100.4	73.1	18.3
RD-R-1	DWORSHAKH	10,000	05104	*	2.700	D	05108	4	100.4	73.1	18.3
RD-R-3	DWORSHAKH	10,000	05/04	*	3,832	D	05/10	6	101.0	73.1	12.2
Imnaba River Drainage											
LA-J-3	LITTLE SHEEP CR	20.771	04/28		6,944	B	05/07	9	99.3	122.0	13.6
RA-J-3	LITTLE SHEEP CR	20.314	04/28		9.551	B	05/07	9	99.3	122.0	13.6
LA-J-I	LITTLE SHEEP CR	20.126	04/28		5.159	B	05110	12	101.0	122.0	10.2
RA-J-I	LITTLE SHEEP CR	20.198	04128		6.406	C	05/07	9	99.3	122.0	13.6
Grand Ronde River Draimge											
LA-I-2	WALLOWA H	20.510	"4119		IO.940	B	05109	20	99.3	182.6	9.1
RA-J-2	WALLOWA H	20.735	04/19		9.742	B	05109	20	99.3	182.6	9.1

- An asterisk designates a release made **over** a number of days for which an estimated median release date is shown.
- **Code designates** range for number of branded fish observed in sample: $A \geq 200$, $100 \leq B < 200$, $50 \leq C < 100$, $30 \leq D < 50$, and $E < 30$.
- Travel **time is** estimated median travel time in days.
- **Flow** is average of Lower **Granite** flow **over** the seven **day** period around the estimated date of median passage at Lower Granite **Dam**

Table XVIII. Travel time of freeze branded yearling chinook hatchery smolts in the Lower Granite Dam to McNary Dam index reach, 1993.

	Release				Lower Granite Dam		McNary Dam			index		
Brand	Site		Number	Date	Passage Index	Med. Recap. Date	Passage Index	Code	Med. Recap. Date	Travel Time (days)	Flow (kcfs)	Speed (miles/day)
Imnaha River Drainage												
LA-A-2	IMNAHA	H	20,271	04/12	5.505	05/04	1.523	C	05/17	13	129.9	10.8
RA-A-2	IMNAHA	H	20.384	04/12	7.490	05/06	1.816	C	05/16	10	129.9	14.0
LA-A-4	IMNAHA	H	20.385	04/12	5.793	05/05	799	D	05/18	13	139.4	10.8
RA-A-4	IMNAHA	H	20,094	04/12	4,366	05/03	1.270	D	05/16	13	120.5	10.8
Grande Ronde River Drainage												
LA-A-I	LOOKINGGLASS	H	20.695	04/07	7,168	04/29	1,517	C	05/09	10	102.1	14.0
LA-A-3	LOOKINGGLASS	H	20.541	04/07	5,711	04/27	808	D	05/11	14	104.1	10.0
RA-A-I	LOOKINGGLASS	H	20.537	04/07	7.340	04/28	968	D	05/08	10	98.9	14.0
RA-A-3	LOOKINGGLASS	H	20.047	04/07	5,390	04/27	1.763	C	05/10	13	102.1	10.8

- An asterisk designates a release made over a number of days for which an estimated median release date is shown.
- Code designates range for number of branded fish observed in sample: $A \geq 200$, $100 \leq B < 200$, $50 \leq C < 100$, $30 \leq D < 50$, and $E < 30$.
- Travel time is estimated median travel time in days.
- Flow is Ice Harbor flow averaged over the seven day period around the estimated date of median passage at Ice Harbor Dam.
- Distance from Lower Granite Dam to McNary Dam is 139.8 miles.

Table XIX. Travel time of freeze branded steelhead smolts from release in the Tucannon and Touchet rivers to MeNary and John Day dam, 1993.

	Release				McNary Dam					John Day Dam		
Brand	Site	Number	Date	Miles to McNary	Passage Index	Code	Med. Recap. Date	Travel Time (days)	Flow (kcfs)	Passage Index	Code	M*iJ2p.
RA-H-I	TOUCHETR	20.328	04/17'	98.2	6,006	A	05/08	21	NA	3.961	A	05/08
RA-H-2	TOUCHETR	20,104	04/17*	98.2	5.079	A	05/08	21	NA	2,906	B	05/08
RA-IC-1	TUCANNON R	21.960	04/17*	94.5	3.080	B	05/17	30	104.1	1.228	C	0S/18
'AK-,	TUCANNON R	30.221	04/22 *	94.5	3,285	B	05/11	19	98.9	853	D	05/16
LA-IC-3	TUCANNON R	30.031	04/22'	94.5	3.776	B	05/lI	19	98.9	1.395	c	05/15

- An asterisk designates a release made over a number of days for which an estimated median release date is shown.
- Code designates range for number of branded fish observed in sample: **A ≥ 200, 100 ≤ B < 200, 50 ≤ C < 100, 30 ≤ D < 50, and E < 30.**
- Travel time is estimated median travel time in days.
- Flow is Ice Harbor flow averaged over the seven day period around the estimated date of median passage at Ice Harbor Dam for Tucannon River releases.

Table XX. Travel time of freeze branded yearling and subyearling chinook hatchery smolts in Mid-Columbia River drainage from release to McNary Dam, 1993.

Brand	Release Site	Release Number	Release Date	Passage Index	Code	Med. Recap. Date	Travel Time (days)	Flow (kcfs)	Miles to MCN	Speed (miles/day)
Yearling Chinook										
LA-7T-1	RINGOLD	13,500	04/03 *	4.333	A	04/22	19	58.5	56.0	2.9
RA-7T-1	RINGOLD	14,000	04/03 *	4.493	A	04/24	21	58.5	56.0	2.7
RA-7T-3	RINGOLD	13,600	04/03 *	3.150	A	04/22	19	58.5	56.0	2.9
Subyearling Chinook										
LA-U-2	BELOW PRD DAM	32,042	06/15	6.759	A	07/02	17	96.5	105.1	6.2
LA-U-I	BELOW PRD DAM	42,075	06/18	12.953	A	06/30	12	98.0	105.1	8.8
LD-U-I	BELOW PRD DAM	42,182	06/21	7,316	A	07/03	12	112.9	105.1	8.8
LA-u-3	BELOW PRD DAM	42,160	06/24	12.117	A	07/05	11	101.8	105.1	9.6
LD-U-3	BELOW PRD DAM	42,010	06/27	8.069	A	07/07	10	115.8	105.1	10.5

- An asterisk designates a release made over a number of days for which an estimated median release date is shown.
- Code designates range for number of branded fish observed in sample: $A \geq 200, 100 \leq B < 200, 50 \leq C < 100, 30 \leq D < 50$, and $E < 30$.
- Travel time is estimated median travel time in days.
- Flow is average of Priest Rapids flow for release date and subsequent three days after release.

Table XXI. Travel time of freeze branded yearling and subyearling chinook hatchery smolts in the McNary Dam to John Day Dam index reach. 1993.

	Release			McNary Dam		John Day Dam						
Brand	Site	Number	Date	Passage Index	Med. Recap. Date	Passage Index	Code	Med. Recap. Date	Index, Travel Time (days)	Flow 1 (kcfs)	Flow 2 (kcfs)	Temp. (°F)
Yearling Chinook												
LA,RA-A-2,4	IMNAHA R	81,134	04/12	5,408	05/16	810	D	05/20	4	385.9	377.4	58.3
LA,RA-A-1,3	LOOKINGGLASS H	81.820	04/07	5.056	05/10	910	E	05/13	3	288.2	258.3	54.7
LA,RA-7T-1. RA-7T-3	RINGOLD H	41.100	04/03 *	11,976	04/23	3.787	A	04/27	4	138.4	128.9	51.0
LA,RA-B-1	UMATILLA R	10,234	03/23	NA	NA	401	D	04/30	NA	163.8	NA	NA
LA,RA-B-3	UMATILLA R	10.790	03/24	NA	NA	428	D	05/03	NA	185.8	NA	NA
LA,RA-5-2,4	UMATILLA R	40,507	06/01	NA	NA	968	E	06/22	NA	203.5	NA	NA
LA,RA-5-1	UMATILLA R	18,264	06/02	NA	NA	376	E	06/22	NA	203.5	NA	NA
Subyearling Chinook												
LA-U-2	BELOW PRD DAM	32.042	06/15	6.759	07/02	321	E	07/06	4	166.1	171.2	63.5
LA-U-I	BELOW PRD DAM	42,075	06/18	12,953	06/30	719	C	07/05	5	169.3	183.7	63.8
LD-U-I	BELOW PRD DAM	42.182	06/21	7,316	07/03	157	E	07/09	6	158.5	165.5	64.2
LA-U-3	BELOW PRD DAM	42.160	06/24	12,117	07/05	545	D	07/10	5	162.7	165.3	64.6
LD-U-3	BELOW PRD DAM	42,010	06/27	8,069	07/07	96	E	07/11	4	158.3	173.6	64.8
LA,RA-J-1	UMATILLA R	277	05/12	NA	NA	8	E	06/09	NA	251.3	NA	NA
LA-J-2.3	UMATILLA R	283	05/13 *	NA	NA	39	E	06/20	NA	177.9	NA	NA
LA,RA-E-2, LA,RA-L-3,4	UMATILLA R	59,578	05/24	NA	NA	3,854	B	06/24	NA	193.0	NA	NA
LA,RA-L-1,2	UMATILLA R	41,111	05/25	NA	NA	1.978	C	06/24	NA	193.0	NA	NA

- An asterisk designates a release made over a number of days for which an estimated median release date is shown.
- Code designates range for number of branded fish observed in sample: $A \geq 200$, $100 \leq B < 200$, $50 \leq C < 100$, $30 \leq D < 50$, and $E < 30$.
- Travel time is estimated median travel time in days.
- Flow 1 is average of John Day flow over the seven day period around the estimated median date of passage at John Day Dam.
- Flow 2 is average of John Day flow over the period from date of median passage at McNary Dam through the date preceding median passage at John Day Dam.
- Temperature is average of John Day water temperature over the period from date of median passage at McNary Dam through tbe date preceding median passage at John Day Dam.
- Distance from McNary Dam to John Day Dam is 76 miles.

Table XXII. Travel time of freeze branded yearling and subyearling chinook and steelhead smolts from McNary Dam (site of marking and release) to John Day Dam, 1993.

Brand Groups	Release Dates	Release Med. Date	Release Number	Med. Recap. Date	Number Sampled	Passage Index	Percent Detected	Travel Time (days)	Flow (kcfs)	Temperature (°F)
Yearling Chinook										
RA-IX	4/19-21	04/20	2.751	04/30	72	800	29.1%[a]	9.5	140.2	50.5
RD-IX	4/22-24	04/23	4,279	05/01	56	669	15.6%'	7.5	149.3	51.3
RA-10	4/26-28	04/27	3.918	05/04	92	1,216	31.0%'	6.5	173.5	51.7
RD-10	4/29-5/1	04/30	3.796	05/05	45	610	16.1%	5.1	195.3	51.6
15	5/3-7	05/05	8.005	05/10	43	692	8.6%'	4.5	242.6	51.6
ID	5/10-14	05/12	7,900	05/16	9	191	2.4%[b]	3.7	324.7	54.3
IF	5/17-21	05/19	10.029	05/22	12	280	2.8%[b]	3.0	386.9	59.2
IM	5/24-28	05/26	8,975	05/29	34	542	6.0%[b]	3.4	311.9	58.7
Subyearling Chinook										
RA-W-1..3	6/24-26	06/25	11,872	07/01	202	2,491	21.0%'	6.3	183.3	64.2
RA-w-4. LA-W-l.2	6/27-29	06/28	12.027	07/03	153	1.771	14.7%'	5.1	191.3	63.4
LA-W-3.4. RA-2J-1	6/30-7/1	07/01	12,045	07/09	lb8	1,944	16.1%'	8.5	169.4	64.4
RA-2T-1,3, LA-2T-1	7/9-11	07/10	11,879	07/28	95	941	7.9%[a]	17.6	160.0	65.4
LA-ZT-3. RA-2P-1,3	7/12-14	07/13	11.858	08/02	loo	949	8.0%'	20.0	160.0	66.2
LA-ZP-1.3. RA-9U-1,3	7/15-18	07/16	11.819	08/13	102	834	7.1%'	28.0	148.9	67.7
RA-2V-1,3, LA-2V-1	7/27-29	07/28	11,798	08/15	79	628	5.3%'	17.9	134.3	69.1
LA-ZV-3. RA-2L-1,3	7/30-8/1	07/31	11.850	08/13	127	1,008	8.5%'	13.3	131.7	69.2
LA-ZL-1.3. RA-2C-1	8/2-4	08/03	11,930	08/16	224	1,694	14.2%'	12.5	121.8	69.5
Steelbead										
LA-13-1,2	5/3-4	05/03	1.997	05/07	112	1,752	87.7%'	4.0	216.0	50.5
LA-13.3. ID-13	5/5-7	05/06	I.959	05/10	49	755	38.6%'	3.5	249.3	51.5
17'	5/11-14	05/13	3,334	05/16	29	632	19.0%'	2.8	343.3	54.7
IV	5/17-21	05/19	3,907	05/22	33	739	18.9%[b]	2.7	386.9	59.2

[a] Two airlifts in operation.

[b] One airlift in operation.

[c] LA-17-1 omitted since powerhouse sample unit was not in operation during early passage of this group.

• Travel time is estimated median of distribution of travel time estimates for individual marked fish recovered at John Day Dam.

• Flow is average of John Day flow over the period beginning the date after release (since 2200 hr release) through the date of median recover at John Day Dam.

• Temperature is average of John Day water temperature over the period beginning the date after release (since 2200 hr release) through the date of median recover at John Day Dam.

• Distance from McNary Dam to John Day Dam is 76.4 miles.

Appendix **F:**

1993 Columbia Basin Hatchery Release Schedules

* These data are preliminary and have been derived from various sources. For *
* verification and/or origin of data, contact the operators of the Fish Passage Data *
* System at (503) 230-4289. *
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FROM 9/01/92 TO 12/31/93

AGCY HATCHERY	SPECIES AGE & STOCK	BRD YR	SIZE #/lb	MGR YR	RELEASE DATES	NUMBER RELEASED	RELEASE SITE	RIVER NAME	ZONE	FPC LOT ID	COMMENTS
IDFG CLEARWATER	SU STEELHEAD DWOR B	92	9	93	4/12/93 4/14/93	326,300	S F CLEARWATER	S F CLEARWATER	SNAK	93341	RELEASED AT STITES BRIDGE
	SP CHINOOK 1 CLEARWATER	92	36	94	7/20/93 7/20/93	144,863	WHITE SANDS CR	LOCHSA R	SNAK	93314	100% LV CLIP; 1K PIT EACH REL SITE; SUPPLEMENTAL RELEASES INTO WHITE SANDS CR (80K), SQUAW CR (12K), PETER KING CR (12K), BIG FLAT CR (41K).
	SP CHINOOK 1 CLEARWATER	92	100	94	7/20/93 7/20/93	113,700	MEADOW CR	SELWAY R	SNAK	93317	100% AD CLIP AND CWT 10-35-25,26; 4K CAUDAL DYE MARK
*					HATCHERY TOTAL.	584,863	FROM 3 RELEASES				*
MAGIC VALLEY	SU STEELHEAD DWOR B	92	6	93	4/07/93 4/09/93	497,400	E F SALMON R	E F SALMON R	SNAK	93316	INCLUDES E FK B STOCK
	SU STEELHEAD PAHSIMEROI A	92	6	93	4/12/93 4/13/93	266,300	SALMON R	SALMON R	SNAK	93303	RELEASED AT ELLIS, ID
	SU STEELHEAD PAHSIMEROI A	92	5	93	4/13/93 4/14/93	260,600	SALMON R	SALMON R	SNAK	93302	RELEASED AT CHALLIS, ID
	SU STEELHEAD PAHSIMEROI A	92	5	93	4/14/93 4/16/93	198,500	LEMHI R	SALMON R	SNAK	93315	
	SU STEELHEAD DWORSHAK B	92	6	93	4/15/93 4/15/93	187,100	SLATE CR	SALMON R	SNAK	93322	
	SU STEELHEAD PAHSIMEROI A	92	5	93	4/16/93 4/22/93	190,500	N F SALMON R	N F SALMON R	SNAK	93301	
	SU STEELHEAD DWOR B	92	6	93	4/16/93 4/21/93	325,300	LITTLE SALMON R	SALMON R	SNAK	93312	
*					HATCHERY TOTAL.	1,925,700	FROM 7 RELEASES				*
MCCALL	SU CHINOOK 1 SOUTH FORK	91	20	93	4/03/93 4/04/93	308,800	S F SALMON R	S F SALMON R	SNAK	93309	100% CWT 10-36-02 US CANADA; 132K RV CLIP ONLY; 150K CWT 10-32-25..27. 3K PITS; .5K PITS ON 4/09
	SU CHINOOK 1 SOUTH FORK	91	17	93	4/21/93 4/22/93	298,500	S F SALMON R	S F SALMON R	SNAK	93323	100% CWT 10-36-02; 10-32-25..27; 499 PITS ON 4/22; 499 PITS ON 5/5
*					HATCHERY TOTAL.	607,300	FROM 2 RELEASES				*
NIAGARA SPRINGS	SU STEELHEAD PAHSIMEROI A	92	5	93	4/19/93 4/28/93	761,800	PAHSIMEROI R	PAHSIMEROI R	SNAK	93320	120K CWT 10-44-1..6; 900 PITS
	SU STEELHEAD OXBOW A	92	5	93	4/22/93 5/02/93	660,500	HELLS CANYON	SNAKE R	SNAK	93318	354K OXBOW STOCK REARED AT NIAGRA SPR, 306K HAULED FROM COMMERCIAL HATCHERY TO HELLS CANYON
	SU STEELHEAD OXBOW A	92	5	93	5/11/93 5/15/93	222,560	SALMON R	SALMON R	SNAK	93311	COMMERCIALLY REARED
*					HATCHERY TOTAL.	1,644,860	FROM 3 RELEASES				*
PAHSIMEROI	SU CHINOOK 1 PAHSIMEROI	91	13	93	4/14/93 4/19/93	375,000	PAHSIMEROI R	PAHSIMEROI R	SNAK	93310	
*					HATCHERY TOTAL.	375,000	FROM 1 RELEASES				*
POWELL	SP CHINOOK 1 CLEARWATER	91	23	93	9/05/92 9/05/92	8,300	POWELL	LOCHSA R	SNAK	92317	ACCLIM AT POWELL; 7.8K REL CROOKED FORK, 0.5K REL POWELL EARLY REARING AT CLEARWATER H.
*					HATCHERY TOTAL.	8,300	FROM 1 RELEASES				*

FISH PASSAGE DATA SYSTEM
* H a t c h e r y R e l e a s e s *

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FROM 9/01/92 TO 12/31/93

AGCY HATCHERY...	SPECIES...... AGE & STOCK	BRD YR	SIZE #/lb	MGR YR	RELEASE DATES	NUMBER RELEASED	RELEASE SITE	RIVER NAME	ZONE	FPC LOT ID	COMMENTS
IDFG RAPID RIVER	SP CHINOOK 0 RAPID RIVER	91	133	93	9/01/92 9/01/92	100,251	WHITE SANDS CR	LOCHSA R	SNAK	93304	RELEASED 10K AT SQUAW CREEK; RV CLIP, NO CWT FINGERLING RELEASES ACTUAL RELEASE DATE: 7/23/92
	SP CHINOOK 1 RAPID RIVER	91	25	93	4/14/93 4/19/93	2,060,300	RAPID R	RAPID R	SNAK	93306	300K CWT 10-36-01; 3.5K PIT
	SP CHINOOK 1 RAPID RIVER	91	27	93	4/16/93 4/16/93	200,300	HELLS CANYON	SNAKE R	SNAK	93307	
*					HATCHERY TOTAL.	2,360,851	FROM 3 RELEASES				*
RED RIVER	SP CHINOOK 1 CLEARWATER	91	16	93	10/19/92 10/19/92	6,000	RED R	S F CLEARWATER	SNAK	92321	
*					HATCHERY TOTAL.	6,000	FROM 1 RELEASES				*
SAWTOOTH	SP CHINOOK 1 SAWTOOTH	91	25	93	10/02/92 10/07/92	191,500	SALMON R	SALMON R	SNAK	92311	REL UPPER SALMON RIVER. 100% CWT 10-49-43, 10-43-13, 10-50-(01..03), 10-49-12. 100% RV CLIPPED ONLY, 2400 PITS
	SP CHINOOK 1 SAWTOOTH	91	25	93	10/02/92 10/08/92	381,300	SAWTOOTH	SALMON R	SNAK	92314	SUPPLEMENTATION FISH REL ABOVE SAWTOOTH WEIR 100% CWT 10-42-19,20; 10-50-(23..30); 10-49-(13,14); 10-43-11. 4800 PITS
	SP CHINOOK 1 SALMON	91	25	93	4/02/93 4/05/93	109,600	SAWTOOTH	SALMON R	SNAK	93308	
	SP CHINOOK 1 SALMON	91	23	93	4/20/93 4/20/93	51,900	SALMON R	SALMON R	SNAK	93305	SUPPLEMENTATION REL ABOVE SAWTOOTH WEIR
	SP CHINOOK 1 SALMON	91	23	93	4/20/93 4/20/93	33,500	E F SALMON R	E F SALMON R	SNAK	93313	SUPPLEMENTATION FISH REL ABOVE EAST FORK WEIR
*					HATCHERY TOTAL.	767,800	FROM 5 RELEASES				*
**					AGENCY TOTAL...	8,280,674	FROM 26 RELEASES				*
NMFS MONTLAKE	SOCKEYE WENATCHEE	91	30	93	9/01/92 6/15/93	162,169	CLE ELEM LAKE	YAKIMA R	MCOL	93505	ACTUAL REL DATES INTO LAKES: 6/4/92 - 8/6/92 NOTE: LAKE DID NOT SPILL IN 1993, HOWEVER, 2052 SEINED FROM LAKE IN MAY/JUNE 93 AND REL INTO CLE ELUM RIVER
	SOCKEYE WENATCHEE	91	30	93	3/09/93 6/15/93	14,879	CLE ELEM R.	YAKIMA R	MCOL	93507	100% FB, 7.6K PIT TAGGED ABOUT 1,000 FISH REL INTO CLE ELUM RIVER
	SOCKEYE WENATCHEE	92	500	94	4/12/93 4/14/93	390,000	CLE ELEM LAKE	YAKIMA R	MCOL	93514	UNMARKED FINGERLING PLANTS RELEASED BELOW SALMON LA SAC BRIDGE
	SOCKEYE WENATCHEE	91	30	93	4/27/93 4/27/93	10,024	CLE ELEM LAKE	YAKIMA R	MCOL	93506	100% PIT & FB (RA-UX-1); NOTE: LAKE DID NOT SPILL IN 1993
					HATCHERY TOTAL.	577,072	FROM 4 RELEASES				*
					AGENCY TOTAL...	577,072	FROM 4 RELEASES				

FISH PASSAGE DATA SYSTEM
* H a t c h e r y   R e l e a s e s *

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FROM 9/01/92 TO 12/31/93

AGCY HATCHERY...	SPECIES...... AGE & STOCK	BRD YR	SIZE #/lb	MGR YR	RELEASE DATES	NUMBER RELEASED	RELEASE SITE	RIVER NAME	ZONE	FPC LOT ID	COMMENTS
ODFW BIG CANYON	SU STEELHEAD WALLOWA	92	5	93	4/23/93 4/23/93	223,943	BIG CANYON	WALLOWA R	SNAK	93752	50K CWT 07-61-2,3; ACCLIM AT BIG CANYON; REL DEER CR; LSRCP EVALUATION.
	SU STEELHEAD WALLOWA	92	5	93	5/07/93 5/07/93	157,460	BIG CANYON	WALLOWA R	SNAK	93779	SHORT ACCLIM AT BIG CANYON
*					HATCHERY TOTAL.	381,403	FROM	2 RELEASES			
BONNEVILLE	SP CHINOOK 1 CARSON	91	11	93	11/03/92 11/04/92	132,154	UMATILLA R	UMATILLA R	LCOL	92802	REL NEAR BONIFER ACCLIMATION POND; 100% CWT 07-60-43..46 07-63-46
	FA CHINOOK 1 BONNEVILLE URB	91	9	93	3/18/93 3/18/93	134,837	UMATILLA R	UMATILLA R	LCOL	93100	UMATILLA TRIBAL RELEASE AT RM 62-87; 100% RV CLIP 50K CWT 07-14-60,61
	SP CHINOOK 1 CARSON	91	14	93	3/22/93 3/23/93	186,948	MEACHAM CR	UMATILLA R	LCOL	93171	42K CWT 07-60-45..47; REL NEAR BONIFER POND
	SP CHINOOK 1 DESCHUTES	91	11	93	4/01/93 4/01/93	46,445	W F HOOD R	HOOD R	LCOL	93132	100% CWT 07-33-35; DIRECT STREAM RELEASE
*					HATCHERY TOTAL.	500,384	FROM	4 RELEASES			
CASCADE	COHO TANNER CR	91	20	93	3/15/93 3/17/93	643,694	YAKIMA R	YAKIMA R	MCOL	93102	75K CWT 07-15-24,25,30 PLANTS FOR YAKIMA TRIBE REL IN YAKIMA AND TRIBS BELOW WAPATO DAM
	COHO TANNER CR	91	18	93	4/05/93 4/09/93	892,678	UMATILLA R	UMATILLA R	LCOL	93106	DIRECT STREAM PLANTS FOR UMATILLA TRIBE 75K CWT 07-15-21,22,23.
*					HATCHERY TOTAL.	1,536,372	FROM	2 RELEASES			
IMNAHA	SP CHINOOK 1 IMNAHA	91	24	93	4/12/93 4/12/93	98,935	IMNAHA R	IMNAHA R	SNAK	93126	100% CWT 7-15-40,41; LSRCP EVALUATION
	SP CHINOOK 1 IMNAHA	91	12	93	4/12/93 4/12/93	58,724	IMNAHA	IMNAHA R	SNAK	93127	100% CWT 07-15-37, 38
*					HATCHERY TOTAL.	157,659	FROM	2 RELEASES			
IRRIGON	SU STEELHEAD WALLOWA	92	5	93	4/12/93 4/15/93	200,111	GRANDE RONDE R	GRANDE RONDE R	SNAK	93119	REL. UPPER GRANDE RONDE (SECTION R-2)
	SU STEELHEAD WALLOWA	92	5	93	4/15/93 4/16/93	62,563	CATHERINE CR	GRANDE RONDE R	SNAK	93170	
	SU STEELHEAD WALLOWA	92	5	93	4/23/93 4/23/93	51,574	DEER CR	WALLOWA R	SNAK	93116	REL NEAR BIG CANYON POND; 100% CWT DIRECT STREAM RELEASE
	SU STEELHEAD IMNAHA	92	6	93	4/28/93 4/28/93	48,725	LITTLE SHEEP CR	IMNAHA R	SNAK	93118	DIRECT STREAM REL; 100% CWT 07-60-63; 07-61-01
	SU STEELHEAD IMNAHA	92	6	93	4/29/93 4/29/93	53,692	IMNAHA R	IMNAHA R	SNAK	93122	DIRECT STREAM REL
					HATCHERY TOTAL.	416,665	FROM	5 RELEASES			
	SU STEELHEAD IMNAHA	92	5	93	4/28/93 4/28/93	237,969	LI SHEEP	IMNAHA R	SNAK	93117	ACCLIMATED; 50K CWT 07-60-61,62, LSRCP EVALUATION
					HATCHERY TOTAL.	237,969	FROM	1 RELEASES			
	SP CHINOOK 1 RAPID R	91	20	93	4/07/93 4/07/93	448,219	LOOKINGGLASS CR	GRANDE RONDE R	SNAK	93123	100% CWT 07-15-46..58
					HATCHERY TOTAL.	448,219	FROM	1 RELEASES			

FISH PASSAGE DATA SYSTEM
* Hatchery Releases *

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FROM 9/01/92 TO 12/31/93

AGCY HATCHERY	SPECIES AGE & STOCK	BRD YR	SIZE #/lb	MGR YR	RELEASE DATES	NUMBER RELEASED	RELEASE SITE	RIVER NAME	ZONE	FPC LOT ID	COMMENTS
OAK SPRINGS	WI STEELHEAD HOOD R WILD	92	6	93	4/05/93 4/06/93	48,985	HOOD R	HOOD R	LCOL	93179	100% AD/LP CLIP
	SU STEELHEAD S SANTIAM	92	6	93	4/07/93 5/05/93	70,928	W F HOOD R	HOOD R	LCOL	93195	33.5K RELEASED ON 4/7; 37.4K RELEASED 5/4-5/5
*			HATCHERY TOTAL.			119,913	FROM	2 RELEASES			
ROUND BUTTE	SU STEELHEAD DESCHUTES	92	4	93	3/30/93 4/06/93	166,143	DESCHUTES R	DESCHUTES R	LCOL	93155	100% AD, LP OR RP CLIP; REL BELOW PELTON DAM
	SP CHINOOK 1 DESCHUTES	91	10	93	4/05/93 4/07/93	211,171	DESCHUTES R	DESCHUTES R	LCOL	93153	REARED AND VOLIT. REL FROM PELTON LADDER 100% CWT 07-59-38..40,47,48
	SP CHINOOK 1 DESCHUTES	91	6	93	4/07/93 4/07/93	24,735	DESCHUTES R	DESCHUTES R	LCOL	93154	DIRECT RELEASE GROUP BELOW PELTON DAM 100% CWT 07-50-08 R2
	SP CHINOOK 1 DESHUTES	91	7	93	4/08/93 4/09/93	28,760	HOOD R	HOOD R	LCOL	93133	100% CWT 07-50-22R2
*			HATCHERY TOTAL.			430,809	FROM	4 RELEASES			
UMATILLA	SP CHINOOK 1 CARSON	91	8	93	3/23/93 3/24/93	208,782	UMATILLA R	UMATILLA R	LCOL	93105	130K RV CLIP; 80K CWT 07-57-39..42; 20K FB FOR FISH PASSAGE YEARLING PROD. EVALUATION.
	FA CHINOOK 0	92	194	93	3/29/93 4/29/93	14,626	UMATILLA R	UMATILLA R	LCOL	93120	100% RV CLIP; USED FOR FISH PASSAGE RESEARCH AT WESTLAND CANAL AND 3 MILE DAMS; FRY RELEASES.
	FA CHINOOK 0	92	90	93	5/03/93 5/20/93	14,598	UMATILLA R	UMATILLA R	LCOL	93121	5111 REL ON 5/7 AT MOUTH OF UMAT. R. DUE TO HIGH FLOWS
	FA CHINOOK 0 URB	92	63	93	5/24/93 5/25/93	2,629,917	UMATILLA R	UMATILLA R	LCOL	93103	1.9 M RV CLIP; 300 AD + LV + CWT 07-01-21,26,27;07-63-29..35 140K LV CLIP; 140K BODY TAG; 140K LV BODY TAG OXYGEN VS STD. REARING EVAL. MARKING EFFECTS ON SURVIVAL.
	SP CHINOOK 1 CARSON	92	28	93	6/01/93 6/02/93	667,367	UMATILLA R	UMATILLA R	LCOL	93108	420K LV CLIP; 300K CWT 07-61-32..37; 60K FB FOR FISH PASSAGE 1,2,3, PASS OXYGEN ---NOTE! THESE ARE LARGE SUBYEARLING CHINOOK WITH AN "ARTIFICIAL" AGE CLASSIFICATION TO MINIMIZE BRAND MISINTERPRETRATIONS AT JDA AND BON.
	SP CHINOOK 1 CARSON	92	20	94	11/16/93 11/17/93	461,024	UMATILLA R	UMATILLA R	LCOL	93152	353 CWT 07-01-56..63, 07-02-16; DIRECT STREAM REL MAINSTEM UMATILLA R ABOUT 2 MI BELOW BONIFER ACCLIMATION SITE
*			HATCHERY TOTAL.			3,996,314	FROM	6 RELEASES			
WALLOWA	SU STEELHEAD WALLOWA	92	5	93	4/19/93 4/19/93	495,164	SPRING CR CHNL	WALLOWA R	SNAK	93115	WALLOWA ACCLIM. POND; 50K CWT 07-61-6,7; LSRCP EVALUATION
	SU STEELHEAD WALLOWA	92	5	93	5/05/93 5/05/93	161,063	SPRING CR CHNL	WALLOWA R	SNAK	93785	WALLOWA ACCLIMATION POND
*			HATCHERY TOTAL.			656,227	FROM	2 RELEASES			
**			AGENCY TOTAL...			8,881,934	FROM	31 RELEASES			
UMTR BONIFER	SP CHINOOK 1 CARSON	91	18	93	4/09/93 4/29/93	85,134	UMATILLA R	UMATILLA R	LCOL	93601	REARED AT CARSON H. 67% RV CLIP; 33K CWT/AD CLIP
	SP CHINOOK 1 CARSON	91	18	93	4/15/93 4/29/93	10,908	UMATILLA R	UMATILLA R	LCOL	93604	REARED AT CARSON H; 67% RV CLIP; 33% CWT REL AT WESTLAND AND 3 MILE DAM FOR FISH PASSAGE RESEARCH
	SU STEELHEAD UMATILLA	92	6	93	4/18/93 5/13/93	110,289	BONIFER	UMATILLA R	LCOL	93602	PART ACCLIM FOR 3 WEEKS AT BONIFER; REL ON 4/18 (45K), REMAINDER REL ON 5/13, 22K CWT, AD/LV CLIP 27K FB
	SU STEELHEAD UMATILLA	92	6	93	4/19/93 4/19/93	47,979	MINTHORN	UMATILLA R	LCOL	93603	29K CWT; ACCLIM FOR 3 WKS AT MINTHORN
*			HATCHERY TOTAL.			254,310	FROM	4 RELEASES			
**			AGENCY TOTAL...			254,310	FROM	4 RELEASES			

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FROM 9/01/92 TO 12/31/93

AGCY HATCHERY	SPECIES AGE & STOCK	BRD YR	SIZE #/lb	MGR YR	RELEASE DATES	NUMBER RELEASED	RELEASE SITE	RIVER NAME	ZONE	FPC LOT ID	COMMENTS
USFW CARSON	SP CHINOOK 1 CARSON	91	19	93	4/14/93 4/15/93	2,321,285	CARSON	WIND R	LCOL	93201	769K CWT/AD CLIP 63-46-32..39, 63-46-08
*					HATCHERY TOTAL.	2,321,285	FROM 1 RELEASES				*
DWORSHAK	SP CHINOOK 1 CLEARWATER	91	17	93	4/08/93 5/06/93	467,222	DWORSHAK	N F CLEARWATER	SNAK	93203	REL 130K ON 4/8,82K ON 4/15; 6K PITS; 100% CWT/AD CLIP 125K ON 4/22 AND 130K ON 5/6
	SU STEELHEAD DWOR B	92	6	93	4/19/93 4/23/93	88,500	CLEARWATER R	CLEARWATER R	SNAK	93207	REL INTO CLEARWATER R. AT KAMIAH; 100% CWT
	SU STEELHEAD DWOR B	92	6	93	4/19/93 4/23/93	342,874	KOOSKIA	M F CLEARWATER	SNAK	93231	REL IN CLEAR CREEK; 100% CWT
	SU STEELHEAD DWOR B	92	6	93	4/19/93 4/23/93	739,629	S F CLEARWATER	S F CLEARWATER	SNAK	93232	REL NEAR STITES (LOWER SOUTH FORK); 60K CWT
	SU STEELHEAD DWOR B	92	7	93	5/03/93 5/04/93	1,217,990	DWORSHAK	N F CLEARWATER	SNAK	93204	1.5K PITS; 160K CWT
*					HATCHERY TOTAL.	2,856,215	FROM 5 RELEASES				*
ENTIAT	SP CHINOOK 1 ENTIAT	91	15	93	4/01/93 4/01/93	376,462	ENTIAT	ENTIAT R	MCOL	93205	120K CWT CONTRIBUTION 05-28-47..50
	SP CHINOOK 0 ENTIAT	92	42	93	5/14/93 5/14/93	332,178	ENTIAT	ENTIAT R	MCOL	93229	200K CWT
*					HATCHERY TOTAL.	708,640	FROM 2 RELEASES				*
HAGERMAN	SU STEELHEAD PAH/SAWTOOTH	92	5	93	4/09/93 4/14/93	666,600	SAWTOOTH	SALMON R	SNAK	93206	ACCLIM AT SAWTOOTH H FOR 3 WEEKS; ?K CWT 10-49-49..51
	SU STEELHEAD PAH/SAWTOOTH	92	5	93	4/09/93 4/09/93	59,950	SAWTOOTH	SALMON R	SNAK	93214	DIRECT STREAM RELEASE
	SU STEELHEAD SAWTOOTH	92	5	93	4/12/93 4/23/93	547,316	LITTLE SALMON R	SALMON R	SNAK	93228	RELEASED INTO HAZARD CREEK AND INTO STINKY SPRINGS 36K CWT 10-50-17..19
	SU STEELHEAD SAWTOOTH	92	5	93	4/26/93 4/30/93	211,006	SALMON R	SALMON R	SNAK	93241	RELEASED AT HAMMER CREEK; 50K CWT 10-49-46..48
*					HATCHERY TOTAL.	1,484,872	FROM 4 RELEASES				*
KOOSKIA	SP CHINOOK 1 RAPID RIVER	91	20	93	4/19/93 4/19/93	343,437	KOOSKIA	M F CLEARWATER	SNAK	93208	REL INTO CLEAR CR.; 100% CWT/ AD CLIP 05-29-25..30
*					HATCHERY TOTAL.	343,437	FROM 1 RELEASES				*

FISH PASSAGE DATA SYSTEM
* H a t c h e r y   R e l e a s e s *

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FROM 9/01/92 TO 12/31/93

AGCY HATCHERY	SPECIES AGE & STOCK	BRD YR	SIZE #/lb	MGR YR	RELEASE DATES	NUMBER RELEASED	RELEASE SITE	RIVER NAME	ZONE	FPC LOT ID	COMMENTS
USFW LEAVENWORTH	SU STEELHEAD LEAVENWORTH	91	6	93	4/22/93 4/22/93	34,598	LEAVENWORTH	WENATCHEE R	MCOL	93210	
	SP CHINOOK 1 LEAVENWORTH	91	17	93	4/22/93 4/22/93	1,757,925	LEAVENWORTH	WENATCHEE R	MCOL	93325	200K CWT/AD CLIP 05-27-24,25, 05-25-55,56, 05-29-15..22
*					HATCHERY TOTAL.	1,792,523	FROM 2 RELEASES				*
LWHITE SALMON	SP CHINOOK 1 LW SALMON	91	18	93	4/15/93 4/15/93	809,079	LWHITE SALMON	LWHITE SALMON R	LCOL	93255	27.5K CWT/AD CLIP 05-27-20,21
	SP CHINOOK 0 LW SALMON	92	52	93	6/23/93 6/23/93	503,458	LWHITE SALMON	LWHITE SALMON R	LCOL	93202	100K AD-CLIP/CWT 05-28-26,27
	FA CHINOOK 0 L.WH. URB	92	101	93	6/23/93 6/23/93	1,866,901	LWHITE SALMON	LWHITE SALMON R	LCOL	93212	50K CWT/ AD CLIP 05-32-52
*					HATCHERY TOTAL.	3,179,438	FROM 3 RELEASES				*
SPRING CRK	FA CHINOOK 0 SPRING CREEK	92	1192	93	2/01/93 2/01/93	7,663,100	SPRING CRK	LOWER COLUMBIA	LCOL	93247	UNFED FRY
	FA CHINOOK 0 SPRING CREEK	92	110	93	3/18/93 3/18/93	6,856,282	SPRING CRK	LOWER COLUMBIA	LCOL	93216	212K CWT/AD CLIP US CANADA 05-16-50..57, 05-21-33,34,49
	FA CHINOOK 0 SPRING CREEK	92	65	93	4/15/93 4/15/93	3,978,719	SPRING CRK	LOWER COLUMBIA	LCOL	93217	100% CWT AND AD CLIP/LV CLIP OR NO CLIP US/CANADA, DENSITY STUDY AND TAGGING STUDY
	SP CHINOOK 1 CARSON/LW	91	12	93	4/15/93 4/15/93	154,364	WHITE SALMON R	WHITE SALMON R	LCOL	93248	51K CWT 05-19-26
	FA CHINOOK 0 SPRING CREEK	92	35	93	5/20/93 5/21/93	3,475,019	SPRING CRK	LOWER COLUMBIA	LCOL	93244	241K CWT 05-31-67, 05-16-50..57, 05-27-35..37 291K REL AT 28/LB ON 5/21
	SP CHINOOK 0 CARSON/LW	92	30	93	7/01/93 8/12/93	591,500	WHITE SALMON R	WHITE SALMON R	LCOL	93223	100K REL ON 7/1 AT 51/LB
*					HATCHERY TOTAL.	22,718,984	FROM 6 RELEASES				*
WILLARD	COHO WILLARD	91	17	93	4/15/93 4/15/93	3,063,615	WILLARD	LWHITE SALMON R	LCOL	93218	50K CWT 05-27-19,28
*					HATCHERY TOTAL.	3,063,615	FROM 1 RELEASES				*
WINTHROP	SP CHINOOK 1 LEAVENWORTH	91	18	93	4/15/93 4/15/93	950,624	WINTHROP	METHOW R	MCOL	93219	193K CWT CONTRIBUTION 05-28-43..46,51, 05-22-36; 1.5K PITS ABOUT 10% METHOW STOCK
*					HATCHERY TOTAL.	950,624	FROM 1 RELEASES				*

FISH PASSAGE DATA SYSTEM
* H a t c h e r y   R e l e a s e s *

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FROM 9/01/92 TO 12/31/93

AGCY HATCHERY	SPECIES / AGE & STOCK	BRD YR	SIZE #/lb	MGR YR	RELEASE DATES	NUMBER RELEASED	RELEASE SITE	RIVER NAME	ZONE	FPC LOT ID	COMMENTS
USFW WARM SPRINGS	SP CHINOOK 1 WARM SPRINGS	91	10	93	10/01/92 10/01/92	23,775	WARM SPRINGS	WARM SPRINGS R	LCOL	92249	GRADED RELEASE, 100% CWT/AD CLIP
	SP CHINOOK 1 WARM SPRINGS	91	10	93	10/01/92 11/13/92	23,482	WARM SPRINGS	WARM SPRINGS R	LCOL	92250	VOLITIONAL RELEASE, 100% CWT/AD CLIP
	SP CHINOOK 1 WARM SPRINGS	91	12	93	3/25/93 4/21/93	240,202	WARM SPRINGS	WARM SPRINGS R	LCOL	93209	VOLITIONAL RELEASE 100% CWT/AD CLIP
	SP CHINOOK 1 WARM SPRINGS	91	12	93	4/21/93 4/21/93	269,555	WARM SPRINGS	WARM SPRINGS R	LCOL	93220	100% CWT/AD CLIP; FORCED RELEASE

HATCHERY TOTAL.	557,014	FROM 4 RELEASES
AGENCY TOTAL...	39,976,647	FROM 30 RELEASES

FISH PASSAGE DATA SYSTEM
* Hatchery Releases *

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FROM 9/01/92 TO 12/31/93

AGCY	HATCHERY	SPECIES AGE & STOCK	BRD YR	SIZE #/lb	MGR YR	RELEASE DATES	NUMBER RELEASED	RELEASE SITE	RIVER NAME	ZONE	FPC LOT ID	COMMENTS
WDF	EAST BANK	SOCKEYE WENATCHEE	91	22	93	10/20/92 10/20/92	167,523	LAKE WENATCHEE	WENATCHEE R	MCOL	92082	100% CWT 63-41-24
		SU CHINOOK 1 WELLS	91	20	93	4/05/93 4/09/93	675,500	SIMILKAMEEN R	OKANOGAN R	MCOL	93049	REARED AT SIMILKAMEEN ACCLIM FACILITY 361K CWT 63-46-04 AND AD CLIP
		SP CHINOOK 1 CHIWAWA	91	15	93	4/21/93 4/28/93	62,138	CHIWAWA R	WENATCHEE R	MCOL	93059	REARED AT CHIWAWA ACCLIM FACILITY; VOLITIONAL RELEASE 100% CWT: 63-43-35; 63-46-46; 63-59-52
		SU CHINOOK 1 WENATCHEE	91	11	93	4/22/93 5/25/93	191,179	WENATCHEE R	WENATCHEE R	MCOL	93048	REARED AT DRYDEN ACCLIM FACILITY; VOLITIONAL RELEASE 100% CWT AND AD CLIP 63-46-13, 63-42-15
		SOCKEYE WENATCHEE	92	75	94	8/13/93 9/07/93	206,657	LAKE WENATCHEE	WENATCHEE R	MCOL	93078	71K LV CLIP; 135K AD AND CWT 63-51-52
	*					HATCHERY TOTAL.	1,302,997	FROM 5 RELEASES				*
	KLICKITAT	FA CHINOOK 0 LYONS FERRY	92	1150	93	1/26/93 3/18/93	33,000	KLICKITAT R	KLICKITAT R	LCOL	93005	UNFED FRY REL. 23K REL ON 1/26 10K REL ON 3/17
		SP CHINOOK 1 KLICKITAT	91	8	93	3/15/93 3/16/93	370,000	KLICKITAT R	KLICKITAT R	LCOL	93003	
		SP CHINOOK 1 KLICKITAT	91	8	93	4/30/93 4/30/93	234,300	KLICKITAT R	KLICKITAT R	LCOL	93035	240K CWT 63-45-2...7
		COHO TYPE-N	91	17	93	5/01/93 6/15/93	1,360,000	KLICKITAT R	KLICKITAT R	LCOL	93038	VOLITIONAL RELEASE, MAY = 968K, JUN = 392K 40K CWT 63-44-40
		FA CHINOOK 0 PRIEST RAPIDS	92	76	93	5/21/93 6/25/93	4,152,000	KLICKITAT R	KLICKITAT R	LCOL	93013	75% PRIEST RAPIDS STOCK; 25% LYONS FERRY STOCK 225K CWT 63-49-24, 63-47-36,39 2.2M REL 5/21, REMAINDER REL 6/16 AND 6/25
		SP CHINOOK 0 KLICKITAT	92	63	93	6/10/93 6/10/93	346,400	KLICKITAT	KLICKITAT R	LCOL	93066	REL. INTO UPPER KLICKITAT BASIN. 225K CWT 63-50-03; INCLUDES 41K UNFED FRY PLANT ON 1/4/93
	*					HATCHERY TOTAL.	6,495,700	FROM 6 RELEASES				*
	LYONS FERRY	FA CHINOOK 1 SNAKE R	91	13	93	4/12/93 4/19/93	760,018	LYONS FERRY	SNAKE R	SNAK	93060	415K RELEASED ON-SITE 4/12; CWT 63-46-31,55,58...63 209K VI TAGGED (LEFT EYELID) 345K BARGED BELOW ICE HARBOR DAM ON 4/19; 126K VI TAGGED CWT 63-37-31, 63-46-18,56,57, 63-47-3,5,6,9
		FA CHINOOK 0 SNAKE R	92	61	93	6/24/93 6/24/93	206,775	LYONS FERRY	SNAKE R	SNAK	93067	100% CWT 63-50-12
	*					HATCHERY TOTAL.	966,793	FROM 2 RELEASES				*

FISH PASSAGE DATA SYSTEM
* Hatchery Releases *

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FROM 9/01/92 TO 12/31/93

AGCY	HATCHERY	SPECIES AGE & STOCK	BRD YR	SIZE #/lb	MGR YR	RELEASE DATES	NUMBER RELEASED	RELEASE SITE	RIVER NAME	ZONE	FPC LOT ID	COMMENTS
WDF	METHOW	SP CHINOOK 1 LEAVENWORTH	91	9	93	4/15/93 4/15/93	22,559	METHOW R	METHOW R	MCOL	93028	
		SOCKEYE OKANOGAN	92	420	94	4/27/93 4/27/93	38,200	OSOYOOS LAKE	MID COLUMBIA R	MCOL	93033	
		SU CHINOOK 1 WELLS	91	10	93	5/12/93 5/12/93	540,900	METHOW R	METHOW R	MCOL	93088	377K CWT 63-46-03
	*					HATCHERY TOTAL.	601,659	FROM 3 RELEASES				
	PRIEST RAPIDS	FA CHINOOK 0 PRIEST RAPIDS	92	50	93	6/15/93 6/27/93	6,386,000	BELOW PRD DAM	MID COLUMBIA R	MCOL	93041	935K LITTLE WHITE STOCK; 200K CWT 63-50-10 US CANADA 200K FB
	*					HATCHERY TOTAL.	6,386,000	FROM 1 RELEASES				
	RINGOLD	SP CHINOOK 1 MIXED STOCK	91	7	93	4/01/93 4/04/93	669,400	RINGOLD	MID COLUMBIA R	MCOL	93040	138K RINGOLD STOCK; 69K CARSON STOCK; 463K KALAMA STOCK 47K AD CLIP/CWT 63-44-46
	*					HATCHERY TOTAL.	669,400	FROM 1 RELEASES				
	ROCKY REACH	COHO KALAMA TYPE-S	91	14	93	5/05/93 5/07/93	524,000	ABOVE RRH DAM	MID COLUMBIA R	MCOL	93043	REARED AT TURTLE ROCK, 45K CWT/AD CLIP 63-44-43
		FA CHINOOK 1 PRIEST RAPIDS	91	9	93	5/13/93 5/14/93	201,000	ABOVE RRH DAM	MID COLUMBIA R	MCOL	93042	REARED AT TURTLE ROCK 92K CWT/AD 63-46-17
		FA CHINOOK 0 PRIEST RAPIDS	92	50	93	6/29/93 6/30/93	1,522,000	ABOVE RRH DAM	MID COLUMBIA R	MCOL	93007	REARED AT TURTLE ROCK; 75K CWT; 63-50-58; 3K PIT. 80% PRIEST STOCK, 20% WELLS STOCK
	*					HATCHERY TOTAL.	2,247,000	FROM 3 RELEASES				
	TUCANNON	SP CHINOOK 1 TUCANNON	91	15	93	4/06/93 4/12/93	74,058	TUCANNON R	TUCANNON R	SNAK	93039	100% CWT/AD CLIP; 17K 63-46-47; 57K 63-46-25 100% VI TAG IN LEFT OR RIGHT EYELID
	*					HATCHERY TOTAL.	74,058	FROM 1 RELEASES				
	WASHOUGAL	COHO TYPE-N	91	20	93	4/05/93 4/09/93	2,500,060	KLICKITAT R	KLICKITAT R	LCOL	93032	56K CWT 63-46-26
	*					HATCHERY TOTAL.	2,500,060	FROM 1 RELEASES				
	WDF-COOP	SU CHINOOK 0 WELLS	92	100	93	3/20/93 3/20/93	100	METHOW R	METHOW R	MCOL	93810	REL BY METHOW VALLEY

FISH PASSAGE DATA SYSTEM
* H a t c h e r y   R e l e a s e s *

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FROM 9/01/92 TO 12/31/93

AGCY	HATCHERY.......	SPECIES...... AGE & STOCK	BRD YR	SIZE #/lb	MGR YR	RELEASE DATES	NUMBER RELEASED	RELEASE SITE	RIVER .... NAME	ZONE	FPC LOT ID	COMMENTS..
WDF	WDF-COOP	COHO TYPE-N	92	500	94	4/02/93 4/02/93	300	ABOVE RRH DAM	MID COLUMBIA R	MCOL	93085	REL SITE BETWEEN WENATCHEE AND ENTIAT ON EAST BANK BY WATERVILLE ELEMENTARY SCHOOL
		SP CHINOOK 0 LEAVENWORTH	92	500	94	4/14/93 4/14/93	408	ICICLE R	WENATCHEE R	MCOL	93811	REL BY MISSION VIEW ELEMENTARY SCHOOL
		SU CHINOOK 0 WELLS	92	100	93	4/21/93 4/21/93	190	SIMILKAMEEN R	OKANOGAN R	MCOL	93808	REL BY OROVILLE ELEMENTARY SCHOOL
		FA CHINOOK 0 PRIEST RAPIDS	92	100	93	6/28/93 6/28/93	423	CRAB CR	MID COLUMBIA R	MCOL	93801	REL BY QUINCY HIGH SCHOOL PROBABLY NEAR CRAB CR
	*					HATCHERY TOTAL.	1,421	FROM 5 RELEASES				
	WELLS	SU CHINOOK 1 WELLS	91	15	93	4/16/93 4/21/93	392,330	WELLS	MID COLUMBIA R	MCOL	93047	126K CWT 63-46-9
	*					HATCHERY TOTAL.	392,330	FROM 1 RELEASES				
**						AGENCY TOTAL...	21,637,418	FROM 29 RELEASES				
WDW	CHELAN	SU STEELHEAD WELLS	92	7	93	4/26/93 4/26/93	41,480	ENTIAT	ENTIAT R	MCOL	93405	PLANTED AT RM 10; REARED AT TURTLE ROCK
		SU STEELHEAD WELLS	92	7	93	4/26/93 4/27/93	144,160	WENATCHEE R	WENATCHEE R	MCOL	93406	REARED AT TURTLE ROCK, REL AT RM 7,11,18 & 26
		SU STEELHEAD WELLS	92	7	93	4/28/93 4/28/93	13,600	TURTLE ROCK	MID COLUMBIA R	MCOL	93466	REARED AT TURTLE ROCK
	*					HATCHERY TOTAL.	199,240	FROM 3 RELEASES				
	EAST BANK	SU STEELHEAD WELLS	92	5	93	4/19/93 4/22/93	179,920	WENATCHEE R	WENATCHEE R	MCOL	93407	PLANTED AT RM 7,18 & 26
		SU STEELHEAD WELLS	92	5	93	4/20/93 4/20/93	33,480	ICICLE R	WENATCHEE R	MCOL	93401	REL AT RM 2 OF ICICLE
	*					HATCHERY TOTAL.	213,400	FROM 2 RELEASES				
	LYONS FERRY	SU STEELHEAD LYONS FERRY	92	5	93	4/03/93 4/30/93	113,539	TUCANNON R	TUCANNON R	SNAK	93413	5K WILD TUCANNON R STOCK MARKED WITH LV CLIP 90K FB & CWT 63-48-15..17,47
		SU STEELHEAD HELLS CANYON A	92	5	93	4/14/93 4/22/93	129,800	BELOW LGS DAM	SNAKE R	SNAK	93412	RELEASED BELOW LITTLE GOOSE DAM AT TEXAS RAPIDS; 100% RV CLIPPED
		SU STEELHEAD HELLS CANYON A	92	5	93	4/15/93 4/22/93	136,000	ASOTIN CR	SNAKE R	SNAK	93409	AD AND RV CLIP
		SU STEELHEAD WALLOWA	92	6	93	4/15/93 4/30/93	341,899	GRANDE RONDE R	GRANDE RONDE R	SNAK	93411	292K REL FROM COTTONWOOD ACCLIM. POND; 50K DIRECT STREAM REL IN OR. SECTION OF GRAND RONDE AT WILDCAT CR ON 4/15 AND 4/19
		SU STEELHEAD LYONS FERRY	92	5	93	4/16/93 4/23/93	83,240	WALLA WALLA R	WALLA WALLA R	MCOL	93415	40K CWT 63-59-42,44 & FB
		SU STEELHEAD LYONS FERRY	92	5	93	4/23/93 4/24/93	118,150	LYONS FERRY	SNAKE R	SNAK	93414	50% HELLS CANYON STOCK W/100% RV CLIP
		SU STEELHEAD LYONS FERRY	92	5	93	4/24/93 4/30/93	110,999	TOUCHET R	WALLA WALLA R	MCOL	93416	REL FROM DAYTON ACCLIM POND; 40K FB & CWT 63-46-49, 63-59-41 100% RV CLIP; 20K DIRECT STREAM REL ON 4/19-4/23
	*					HATCHERY TOTAL.	1,033,627	FROM 7 RELEASES				
	RINGOLD	SU STEELHEAD RINGOLD	92	6	93	4/19/93 4/30/93	191,590	RINGOLD	MID COLUMBIA R	MCOL	93410	VOLITIONAL RELEASE
	*					HATCHERY TOTAL.	191,590	FROM 1 RELEASES				

FISH PASSAGE DATA SYSTEM
* Hatchery Releases *

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FROM 9/01/92 TO 12/31/93

AGCY	HATCHERY	SPECIES AGE & STOCK	BRD YR	SIZE #/lb	MGR YR	RELEASE DATES	NUMBER RELEASED	RELEASE SITE	RIVER NAME	ZONE	FPC LOT ID	COMMENTS
WDW	KAMANIA	WI STEELHEAD SKAMANIA	92	7	93	4/12/93 4/28/93	34,271	WHITE SALMON R	WHITE SALMON R	LCOL	93460	REARED AT NORTHWESTERN RES. NET PEN; 21K CWT 63-59-38 R2 7.75K DIRECT STREAM RELEASE ON 4/28/93; ABOUT 17,499 ESCAPED FROM NET PENS AND ARE NOT INCLUDED IN TOTAL.
		WI STEELHEAD	92	6	93	4/27/93 4/27/93	10,645	ROCK CR	LOWER COLUMBIA	LCOL	93002	
		SU STEELHEAD SKAMANIA	92	6	93	4/28/93 4/28/93	31,152	WHITE SALMON R	WHITE SALMON R	LCOL	93418	
		SU STEELHEAD SKAMANIA	92	6	93	4/29/93 4/30/93	71,586	KLICKITAT R	KLICKITAT R	LCOL	93404	REL AT RM 16 & 27
		HATCHERY TOTAL.					147,654	FROM 4 RELEASES				
	VACOUVER	SU STEELHEAD SKAMANIA	92	5	93	4/19/93 4/24/93	40,196	WIND R	WIND R	LCOL	93006	REL AT STABLER AND HIGH BRIDGE
		SU STEELHEAD SKAMANIA	92	5	93	4/20/93 4/23/93	45,032	KLICKITAT R	KLICKITAT R	LCOL	93417	PLANTED AT RM 16
		HATCHERY TOTAL.					85,228	FROM 2 RELEASES				
	WLLS	SU STEELHEAD WELLS	92	7	93	4/19/93 5/04/93	392,815	METHOW R	METHOW R	MCOL	93403	REL AT RM 10, EFFY BRIDGE
		SU STEELHEAD WELLS	92	7	93	4/20/93 4/27/93	51,360	SIMILKAMEEN R	OKANOGAN R	MCOL	93408	PLANTED RM 6 AT OROVILLE
		SU STEELHEAD WELLS	92	7	93	4/23/93 4/29/93	67,120	OKANOGAN R	OKANOGAN R	MCOL	93402	PLANTED 5.5K IN OMAK CR; PLANTED RM 28 IN OKANOGAN
		HATCHERY TOTAL.					511,295	FROM 3 RELEASES				
	YKIMA	SU STEELHEAD	92	8	93	5/03/93 5/12/93	24,320	YAKIMA R	YAKIMA R	MCOL	93428	REARED AT NELSON SPRINGS; REL INTO JUNGLE CR
		HATCHERY TOTAL.					24,320	FROM 1 RELEASES				
		AGENCY TOTAL...					2,406,354	FROM 23 RELEASES				
YATR	PIEST RAPIDS	FA CHINOOK 1 LW URB	92	216	93	5/04/93 5/12/93	748,159	YAKIMA R	YAKIMA R	MCOL	93701	TRANSFERRED FROM L. WHITE SALMON HATCHERY TO PRIEST RAPIDS H 100% CWT/AD 5-1-1-8-7,8,9; REL BELOW PROSSER DAM
		HATCHERY TOTAL.					748,159	FROM 1 RELEASES				
		AGENCY TOTAL...					748,159	FROM 1 RELEASES				

* L A S T P A G E *

Appendix 6:

1993 Columbia Basin Brand Release Schedules

* These data are preliminary and have been derived from various sources. For verification and/or origin of data, contact the operators of the Fish Passage Data System at (503) 230-4289.

AGCY	HATCHERY	SPECIES	AGE	MAJOR RELEASE START	MAJOR RELEASE STOP	TOTAL NUMBER RELEASED	LOT ID	#	LOC	BRND	ROT	BRAND RELEASE START	BRAND RELEASE STOP	BRAND NUMBER RELEASED	RELEASE SITE	RIVER NAME	ZONE	COMMENTS	FPC BRAND
FPC	NON-HATCHERY	SP CHINOOK	1	4/19/93	5/28/93	49,753	93511	01	RA	IX	1	4/19/93	4/19/93	931	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								02	RA	IX	2	4/20/93	4/20/93	986	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								03	RA	IX	3	4/21/93	4/21/93	834	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								04	RD	IX	1	4/22/93	4/22/93	1,107	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								05	RD	IX	3	4/23/93	4/23/93	1,581	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								06	RD	IX	2	4/24/93	4/24/93	1,591	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								08	RA	10	1	4/26/93	4/26/93	1,234	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								09	RA	10	2	4/27/93	4/27/93	1,369	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								10	RA	10	3	4/28/93	4/28/93	1,315	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								11	RD	10	1	4/29/93	4/29/93	1,316	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								12	RD	10	3	4/30/93	4/30/93	1,378	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								13	RD	10	2	5/01/93	5/01/93	1,102	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								15	RA	15	1	5/03/93	5/03/93	725	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								16	RA	15	2	5/04/93	5/04/93	1,787	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								17	RA	15	3	5/05/93	5/05/93	2,314	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								18	RD	15	1	5/06/93	5/06/93	1,881	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								19	RD	15	3	5/07/93	5/07/93	1,298	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								22	RA	ID	1	5/10/93	5/10/93	1,594	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								23	RA	ID	2	5/11/93	5/11/93	1,297	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								24	RA	ID	3	5/12/93	5/12/93	1,512	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								25	RD	ID	1	5/13/93	5/13/93	1,787	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								26	RD	ID	3	5/14/93	5/14/93	1,710	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								29	RA	IF	1	5/17/93	5/17/93	891	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								30	RA	IF	2	5/18/93	5/18/93	2,249	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								31	RA	IF	3	5/19/93	5/19/93	1,884	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								32	RD	IF	1	5/20/93	5/20/93	2,414	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								33	RD	IF	3	5/21/93	5/21/93	2,591	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								36	RA	IM	1	5/24/93	5/24/93	1,366	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								37	RA	IM	2	5/25/93	5/25/93	1,284	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								44	LA	TU	1	5/26/93	5/26/93	50	BELOW MCN DAM	LOWER COLUMBIA	LCOL	NMFS RELEASE SAME FISH MARKED LA & RA	
								38	RA	IM	3	5/26/93	5/26/93	1,884	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								43	RA	TU	1	5/26/93	5/26/93	50	BELOW MCN DAM	LOWER COLUMBIA	LCOL	NMFS RELEASE SAME FISH MARKED LA & RA	
								39	RD	IM	1	5/27/93	5/27/93	2,399	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								40	RD	IM	3	5/28/93	5/28/93	2,042	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
												LOT ID TOTAL.		49,753	FROM 34 RELEASES				
		SU STEELHEAD		5/03/93	5/26/93	11,990	93512	01	LA	13	1	5/03/93	5/03/93	1,059	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								02	LA	13	2	5/04/93	5/04/93	938	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								03	LA	13	3	5/05/93	5/05/93	802	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								04	LD	13	1	5/06/93	5/06/93	659	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								05	LD	13	3	5/07/93	5/07/93	498	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								08	LA	17	1	5/10/93	5/10/93	693	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								09	LA	17	2	5/11/93	5/11/93	706	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								10	LA	17	3	5/12/93	5/12/93	575	BELOW MCN DAM	LOWER COLUMBIA	LCOL		

FISH PASSAGE DATA SYSTEM

* Brand Releases *

FROM 9/01/92 TO 12/31/93

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* System at (503) 230-4289. *

AGCY	HATCHERY.......	SPECIES...	AGE	MAJOR RELEASE START	MAJOR RELEASE STOP	TOTAL NUMBER RELEASED	LOT ID	#	LOC	BRND	ROT	BRAND RELEASE START	BRAND RELEASE STOP	BRAND NUMBER RELEASED	RELEASE SITE...	RIVER NAME	ZONE	COMMENTS...	FPC BRAND
FPC	NON-HATCHERY	SU STEELHEAD		5/03/93	5/26/93	11,990	93512	11	LD	17	1	5/13/93	5/13/93	721	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								12	LD	17	3	5/14/93	5/14/93	1,332	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								15	LA	IV	1	5/17/93	5/17/93	363	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								16	LA	IV	2	5/18/93	5/18/93	783	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								17	LA	IV	3	5/19/93	5/19/93	989	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								18	LD	IV	1	5/20/93	5/20/93	755	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								19	LD	IV	3	5/21/93	5/21/93	1,017	BELOW MCN DAM	LOWER COLUMBIA	LCOL		
								23	LA	TU	1	5/26/93	5/26/93	50	BELOW MCN DAM	LOWER COLUMBIA	LCOL	NMFS RELEASE SAME FISH MARKED LA & RA	
								22	RA	TU	1	5/26/93	5/26/93	50	BELOW MCN DAM	LOWER COLUMBIA	LCOL	NMFS RELEASE SAME FISH MARKED LA & RA	
												LOT ID TOTAL.		11,990	FROM 17 RELEASES				*
**												HATCHERY TOTAL.		61,743	FROM 51 RELEASES				**
***												AGENCY TOTAL...		61,743	FROM 51 RELEASES				***
NMFS	MONTLAKE	SOCKEYE		9/01/92	6/15/93	162,169	93505	01	RA	T	1	9/01/92	6/15/93	81,727	CLE ELEM LAKE	YAKIMA R	MCOL		
								02	RA	T	2	9/01/92	6/15/93	66,740	CLE ELEM LAKE	YAKIMA R	MCOL		
								03	RA	T	4	9/01/92	6/15/93	3,665	CLE ELEM LAKE	YAKIMA R	MCOL		
								04	RA	TJ	1	9/01/92	6/15/93	10,037	CLE ELEM LAKE	YAKIMA R	MCOL	100% PIT TAGGED	
												LOT ID TOTAL.		162,169	FROM 4 RELEASES				
		SOCKEYE		3/09/93	6/15/93	14,879	93507	01	LA	>U	1	3/09/93	3/09/93	1,005	CLE ELEM R.	YAKIMA R	MCOL	500 PITS TAGGED IN SEATTLE ON 3/1-2	
								02	LA	>X	1	3/16/93	3/16/93	1,000	CLE ELEM R.	YAKIMA R	MCOL	500 PITS TAGGED IN SEATTLE ON 3/1-2	
								03	LA	>H	1	3/23/93	3/23/93	1,005	CLE ELEM R.	YAKIMA R	MCOL	500 PITS TAGGED IN SEATTLE ON 3/1-2	
								04	LA	>L	1	3/30/93	3/30/93	1,049	CLE ELEM R.	YAKIMA R	MCOL	500 PITS	
								07	LA	>K	1	4/06/93	4/06/93	1,014	CLE ELEM R.	YAKIMA R	MCOL	500 PITS	
								08	LA	>T	1	4/13/93	4/13/93	1,007	CLE ELEM R.	YAKIMA R	MCOL	500 PITS	
								11	LA	>V	1	4/20/93	4/20/93	1,015	CLE ELEM R.	YAKIMA R	MCOL	500 PITS	
								12	LA	>F	1	4/27/93	4/27/93	1,008	CLE ELEM R.	YAKIMA R	MCOL	500 PITS	
								15	LA	>U	3	5/04/93	5/04/93	1,012	CLE ELEM R.	YAKIMA R	MCOL	500 PITS	
								16	LA	>X	3	5/11/93	5/11/93	1,009	CLE ELEM R.	YAKIMA R	MCOL	500 PITS	
								19	LA	>H	3	5/18/93	5/18/93	1,005	CLE ELEM R.	YAKIMA R	MCOL	500 PITS	
								20	LA	>L	3	5/25/93	5/25/93	1,007	CLE ELEM R.	YAKIMA R	MCOL	500 PITS	
								23	LA	>K	3	6/01/93	6/01/93	1,007	CLE ELEM R.	YAKIMA R	MCOL	500 PITS	
								24	LA	>T	3	6/08/93	6/08/93	1,001	CLE ELEM R.	YAKIMA R	MCOL	500 PITS	
								27	LA	>V	3	6/15/93	6/15/93	735	CLE ELEM R.	YAKIMA R	MCOL	500 PITS	
												LOT ID TOTAL.		14,879	FROM 15 RELEASES				
		SOCKEYE		4/27/93	4/27/93	10,024	93506	01	RA	UX	1	4/27/93	4/27/93	3,665	CLE ELEM LAKE	YAKIMA R	MCOL	100% PIT	
												LOT ID TOTAL.		3,665	FROM 1 RELEASES				
**												HATCHERY TOTAL.		180,713	FROM 20 RELEASES				**
***												AGENCY TOTAL...		180,713	FROM 20 RELEASES				***

FISH PASSAGE DATA SYSTEM

* Brand Releases *

FROM 9/01/92 TO 12/31/93

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* System at (503) [illegible]

AGCY	HATCHERY	SPECIES	AGE	MAJOR RELEASE START	MAJOR RELEASE STOP	TOTAL NUMBER RELEASED	LOT ID	#	LOC	BRND	ROT	BRAND RELEASE START	BRAND RELEASE STOP	BRAND NUMBER RELEASED	RELEASE SITE	RIVER NAME	ZONE	COMMENTS	FPC BRAND
ODFW	IMNAHA	SP CHINOOK	1	4/12/93	4/12/93	98,935	93126	01	LA	A	2	4/12/93	4/12/93	20,271	IMNAHA R	IMNAHA R	SNAK	CWT 07-15-40; AD CLIP	
								02	RA	A	2	4/12/93	4/12/93	20,384	IMNAHA R	IMNAHA R	SNAK	CWT 07-15-41; AD CLIP	
												LOT ID TOTAL.		40,655	FROM 2 RELEASES				
		SP CHINOOK	1	4/12/93	4/12/93	58,724	93127	02	LA	A	4	4/12/93	4/12/93	20,385	IMNAHA	IMNAHA R	SNAK	CWT 07-15-39; AD CLIP	
								01	RA	A	4	4/12/93	4/12/93	20,094	IMNAHA	IMNAHA R	SNAK	CWT 07-15-38; AD CLIP	
												LOT ID TOTAL.		40,479	FROM 2 RELEASES				
												HATCHERY TOTAL.		81,134	FROM 4 RELEASES				
	IRRIGON	SU STEELHEAD		4/28/93	4/28/93	48,725	93118	01	LA	J	3	4/28/93	4/28/93	20,771	LITTLE SHEEP CR	IMNAHA R	SNAK	500 PITS; 100% CWT, AD LV	
								02	RA	J	3	4/28/93	4/28/93	20,314	LITTLE SHEEP CR	IMNAHA R	SNAK	100% CWT, AD LV CLIP	
												LOT ID TOTAL.		41,085	FROM 2 RELEASES				
												HATCHERY TOTAL.		41,085	FROM 2 RELEASES				
	LI SHEEP	SU STEELHEAD		4/28/93	4/28/93	237,969	93117	02	LA	J	1	4/28/93	4/28/93	20,126	LI SHEEP	IMNAHA R	SNAK	500 PITS; AD LV CLIP CWT 07-60-62	
								01	RA	J	1	4/28/93	4/28/93	20,198	LI SHEEP	IMNAHA R	SNAK	500 PITS; AD LV CLIP CWT 07-60-61	
												LOT ID TOTAL.		40,324	FROM 2 RELEASES				
												HATCHERY TOTAL.		40,324	FROM 2 RELEASES				
	LOOKINGGLASS	SP CHINOOK	1	4/07/93	4/07/93	448,219	93123	01	LA	A	1	4/07/93	4/07/93	20,695	LOOKINGGLASS CR	GRANDE RONDE R	SNAK	CWT 07-15-49; AD RV CLIP	
								04	LA	A	3	4/07/93	4/07/93	20,541	LOOKINGGLASS CR	GRANDE RONDE R	SNAK	CWT 07-15-46,47; AD RV	
								02	RA	A	1	4/07/93	4/07/93	20,537	LOOKINGGLASS CR	GRANDE RONDE R	SNAK	CWT 07-15-48; AD RV CLIP	
								03	RA	A	3	4/07/93	4/07/93	20,047	LOOKINGGLASS CR	GRANDE RONDE R	SNAK	CWT 07-15-50,51; AD RV	
												LOT ID TOTAL.		81,820	FROM 4 RELEASES				
												HATCHERY TOTAL.		81,820	FROM 4 RELEASES				
	UMATILLA	SP CHINOOK	1	3/23/93	3/24/93	208,782	93105	02	LA	B	1	3/23/93	3/23/93	4,934	UMATILLA R	UMATILLA R	LCOL	2K CWT 07-57-40	
								01	RA	B	1	3/23/93	3/23/93	5,300	UMATILLA R	UMATILLA R	LCOL	2K CWT 07-57-39	
								04	LA	B	3	3/24/93	3/24/93	5,242	UMATILLA R	UMATILLA R	LCOL	2K CWT 07-57-42	
								03	RA	B	3	3/24/93	3/24/93	5,548	UMATILLA R	UMATILLA R	LCOL	2K CWT 07-57-42	
												LOT ID TOTAL.		21,024	FROM 4 RELEASES				
		FA CHINOOK	0	5/03/93	5/20/93	14,598	93121	33	LA	RH	1	5/03/93	5/03/93	162	UMATILLA R	UMATILLA R	LCOL		
								34	LA	R7	1	5/03/93	5/03/93	146	UMATILLA R	UMATILLA R	LCOL		
								35	LD	RH	1	5/03/93	5/03/93	160	UMATILLA R	UMATILLA R	LCOL		

AGCY	HATCHERY	SPECIES	AGE	MAJOR RELEASE START	MAJOR RELEASE STOP	TOTAL NUMBER RELEASED	LOT ID	#	LOC	BRND	ROT	BRAND RELEASE START	BRAND RELEASE STOP	BRAND NUMBER RELEASED	RELEASE SITE	RIVER NAME	ZONE	COMMENTS	FPC BRAND
ODFW	UMATILLA	FA CHINOOK	0	5/03/93	5/20/93	14,598	93121	36	LD	R7	1	5/03/93	5/03/93	150	UMATILLA R	UMATILLA R	LCOL		
								37	RA	RH	1	5/03/93	5/03/93	159	UMATILLA R	UMATILLA R	LCOL		
								38	RA	R7	1	5/03/93	5/03/93	154	UMATILLA R	UMATILLA R	LCOL		
								39	RD	RH	1	5/03/93	5/03/93	447	UMATILLA R	UMATILLA R	LCOL		
								28	LA	RH	3	5/07/93	5/07/93	149	UMATILLA R	UMATILLA R	LCOL		
								31	LA	RH	4	5/07/93	5/07/93	139	UMATILLA R	UMATILLA R	LCOL		
								01	LA	RR	1	5/07/93	5/07/93	146	UMATILLA R	UMATILLA R	LCOL		
								04	LA	RR	2	5/07/93	5/07/93	150	UMATILLA R	UMATILLA R	LCOL		
								07	LA	RR	3	5/07/93	5/07/93	149	UMATILLA R	UMATILLA R	LCOL		
								09	LA	RR	3	5/07/93	5/07/93	149	UMATILLA R	UMATILLA R	LCOL		
								10	LA	RR	4	5/07/93	5/07/93	125	UMATILLA R	UMATILLA R	LCOL		
								14	LA	R7	2	5/07/93	5/19/93	299	UMATILLA R	UMATILLA R	LCOL	150 REL @ MOUTH OF UMAT. 149 REL @ RM 27.3	
								17	LA	R7	3	5/07/93	5/20/93	299	UMATILLA R	UMATILLA R	LCOL	149 REL @ MOUTH OF UMAT. 150 REL @ RM 27.3	
								20	LA	R7	4	5/07/93	5/07/93	150	UMATILLA R	UMATILLA R	LCOL		
								25	LD	RH	2	5/07/93	5/07/93	149	UMATILLA R	UMATILLA R	LCOL		
								26	LD	RH	2	5/07/93	5/07/93	150	UMATILLA R	UMATILLA R	LCOL		
								29	LD	RH	3	5/07/93	5/07/93	149	UMATILLA R	UMATILLA R	LCOL		
								32	LD	RH	4	5/07/93	5/07/93	139	UMATILLA R	UMATILLA R	LCOL		
								02	LD	RR	1	5/07/93	5/07/93	146	UMATILLA R	UMATILLA R	LCOL		
								05	LD	RR	2	5/07/93	5/07/93	150	UMATILLA R	UMATILLA R	LCOL		
								08	LD	RR	3	5/07/93	5/07/93	149	UMATILLA R	UMATILLA R	LCOL		
								11	LD	RR	4	5/07/93	5/07/93	124	UMATILLA R	UMATILLA R	LCOL		
								15	LD	R7	2	5/07/93	5/19/93	303	UMATILLA R	UMATILLA R	LCOL	148 REL @ MOUTH OF UMAT. 155 REL @ RM 27.3	
								18	LD	R7	3	5/07/93	5/20/93	300	UMATILLA R	UMATILLA R	LCOL	149 REL @ MOUTH OF UMAT. 151 REL @ RM 27.3	
								21	LD	R7	4	5/07/93	5/07/93	150	UMATILLA R	UMATILLA R	LCOL		
								27	RA	RH	2	5/07/93	5/07/93	150	UMATILLA R	UMATILLA R	LCOL		
								30	RA	RH	3	5/07/93	5/07/93	148	UMATILLA R	UMATILLA R	LCOL		
								24	RA	RH	4	5/07/93	5/07/93	140	UMATILLA R	UMATILLA R	LCOL		
								03	RA	RR	1	5/07/93	5/07/93	146	UMATILLA R	UMATILLA R	LCOL		
								06	RA	RR	2	5/07/93	5/07/93	149	UMATILLA R	UMATILLA R	LCOL		
								12	RA	RR	4	5/07/93	5/07/93	125	UMATILLA R	UMATILLA R	LCOL		
								16	RA	R7	2	5/07/93	5/19/93	290	UMATILLA R	UMATILLA R	LCOL	150 REL @ MOUTH OF UMAT. 140 REL @ RM 27.3	
								19	RA	R7	3	5/07/93	5/20/93	300	UMATILLA R	UMATILLA R	LCOL	149 REL @ MOUTH OF UMAT. 151 REL @ RM 27.3	
								22	RA	R7	4	5/07/93	5/07/93	149	UMATILLA R	UMATILLA R	LCOL		
								13	RD	RR	4	5/07/93	5/07/93	297	UMATILLA R	UMATILLA R	LCOL		
								23	RD	R7	4	5/07/93	5/07/93	450	UMATILLA R	UMATILLA R	LCOL		
								60	LA	J	1	5/12/93	5/12/93	135	UMATILLA R	UMATILLA R	LCOL	RM 14.8 MAXWELL CANAL	
								64	LA	J	3	5/12/93	5/13/93	149	UMATILLA R	UMATILLA R	LCOL	RM 14.8 MAXWELL CANAL	
								61	LD	J	1	5/12/93	5/12/93	148	UMATILLA R	UMATILLA R	LCOL	RM 14.8 MAXWELL CANAL	
								62	RA	J	1	5/12/93	5/12/93	142	UMATILLA R	UMATILLA R	LCOL	RM 14.8 MAXWELL CANAL	
								63	RD	J	1	5/12/93	5/12/93	432	UMATILLA R	UMATILLA R	LCOL	RM 14.8 MAXWELL CANAL	

FISH PASSAGE DATA SYSTEM

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AGCY HATCHERY	SPECIES...	AGE	MAJOR RELEASE START	MAJOR RELEASE STOP	TOTAL NUMBER RELEASED	LOT ID	#	LOC	BRI	BRAND RELEASE START	BRAND RELEASE STOP	BRAND NUMBER RELEASED	RELEASE SITE...	RIVER NAME	ZONE	COMMENTS...	FPC BRAND
ODFW UMATILLA	FA CHINOOK	0	5/03/93	5/20/93	14,598	93121	65	RD		5/12/93	5/13/93	463	UMATILLA R	UMATILLA R	LCOL	RM 14.8 MAXWELL CANAL	
							66	LA		5/13/93	5/13/93	134	UMATILLA R	UMATILLA R	LCOL	RM 14.8 MAXWELL CANAL	
							67	LD		5/13/93	5/13/93	138	UMATILLA R	UMATILLA R	LCOL	RM 14.8 MAXWELL CANAL	
							70	LD		5/13/93	5/13/93	135	UMATILLA R	UMATILLA R	LCOL	RM 14.8 MAXWELL CANAL	
							68	RA		5/13/93	5/13/93	152	UMATILLA R	UMATILLA R	LCOL	RM 14.8 MAXWELL CANAL	
							71	RA		5/13/93	5/13/93	125	UMATILLA R	UMATILLA R	LCOL	RM 14.8 MAXWELL CANAL	
							69	RD		5/13/93	5/13/93	436	UMATILLA R	UMATILLA R	LCOL	RM 14.8 MAXWELL CANAL	
							40	LA		5/17/93	5/17/93	147	UMATILLA R	UMATILLA R	LCOL	RM 3.0	
							41	LA		5/17/93	5/17/93	148	UMATILLA R	UMATILLA R	LCOL	RM 3.0	
							42	LD		5/17/93	5/17/93	147	UMATILLA R	UMATILLA R	LCOL	RM 3.0	
							43	LD		5/17/93	5/17/93	149	UMATILLA R	UMATILLA R	LCOL	RM 3.0	
							44	RA		5/17/93	5/17/93	152	UMATILLA R	UMATILLA R	LCOL	RM 3.0	
							45	RA		5/17/93	5/17/93	141	UMATILLA R	UMATILLA R	LCOL	RM 3.0	
							46	RD		5/17/93	5/17/93	162	UMATILLA R	UMATILLA R	LCOL	RM 3.0	
							47	RD		5/17/93	5/17/93	144	UMATILLA R	UMATILLA R	LCOL	RM 3.0	
							52	LA		5/18/93	5/18/93	145	UMATILLA R	UMATILLA R	LCOL	RM 3.0	
							53	LA		5/18/93	5/18/93	300	UMATILLA R	UMATILLA R	LCOL	RM 3.0	
							48	LA		5/18/93	5/18/93	245	UMATILLA R	UMATILLA R	LCOL	RM 3.0	
							54	LD		5/18/93	5/18/93	146	UMATILLA R	UMATILLA R	LCOL	RM 3.0	
							55	LD		5/18/93	5/18/93	304	UMATILLA R	UMATILLA R	LCOL	RM 3.0	
							49	LD		5/18/93	5/18/93	147	UMATILLA R	UMATILLA R	LCOL	RM 3.0	
							56	RA		5/18/93	5/18/93	150	UMATILLA R	UMATILLA R	LCOL	RM 3.0	
							57	RA		5/18/93	5/18/93	298	UMATILLA R	UMATILLA R	LCOL	RM 3.0	
							50	RA		5/18/93	5/18/93	148	UMATILLA R	UMATILLA R	LCOL	RM 3.0	
							58	RD		5/18/93	5/18/93	157	UMATILLA R	UMATILLA R	LCOL	RM 3.0	
							59	RD		5/18/93	5/20/93	768	UMATILLA R	UMATILLA R	LCOL	324 REL @ RM 3.0 444 REL @ RM 27.3	
							51	RD		5/18/93	5/18/93	158	UMATILLA R	UMATILLA R	LCOL	RM 3.0	
							72	RD		5/19/93	5/19/93	467	UMATILLA R	UMATILLA R	LCOL	RM 27.3	
										LOT ID TOTAL.		14,598	FROM 72 RELEASES				
	FA CHINOOK	0	5/24/93	5/25/93	2,629,917	93103	10	LA		5/24/93	5/24/93	9,434	UMATILLA R	UMATILLA R	LCOL	RM 73 100% RV CLIP,10% CWT/AD	
							06	LA		5/24/93	5/24/93	10,027	UMATILLA R	UMATILLA R	LCOL	RM 73 100% RV CLIP, 10% CWT-AD	
							08	LA		5/24/93	5/24/93	10,020	UMATILLA R	UMATILLA R	LCOL	RM 73 100% RV CLIP, 10% CWT-AD	
							09	RA		5/24/93	5/24/93	9,894	UMATILLA R	UMATILLA R	LCOL	RM 73 100% RV CLIP, 10% CWT-AD	
							05	RA		5/24/93	5/24/93	10,053	UMATILLA R	UMATILLA R	LCOL	RM 73 100% RV CLIP, 10% CWT-AD	
							07	RA		5/24/93	5/24/93	10,150	UMATILLA R	UMATILLA R	LCOL	RM 73 100% RV CLIP, 10% CWT-AD	
							02	LA		5/25/93	5/25/93	10,278	UMATILLA R	UMATILLA R	LCOL	RM 73 100% RV CLIP, 10% CWT-AD	
							04	LA		5/25/93	5/25/93	9,828	UMATILLA R	UMATILLA R	LCOL	RM 73 100% RV CLIP, 10% CWT-AD	

FISH PASSAGE DATA SYSTEM
* B r a n d   R e l e a s e s *

FROM 9/01/92 TO 12/31/93

* These data are preliminary and have been derived from various sources. For *
* verification and/or origin of data, contact the operators of the Fish Passage Data *
* System at (503) 230-4289. *

AGCY HATCHERY.......	SPECIES...	AGE	MAJOR RELEASE START	MAJOR RELEASE STOP	TOTAL NUMBER RELEASED	LOT ID	#	LOC	BRND	ROT	BRAND RELEASE START	BRAND RELEASE STOP	BRAND NUMBER RELEASED	RELEASE SITE...	RIVER NAME	ZONE	COMMENTS................	FPC BRAND
ODFW UMATILLA	FA CHINOOK	0	5/24/93	5/25/93	2,629,917	93103	01	RA	L	1	5/25/93	5/25/93	10,547	UMATILLA R	UMATILLA R	LCOL	RM 73 100% RV CLIP, 10% CWT-AD	
							03	RA	L	2	5/25/93	5/25/93	10,458	UMATILLA R	UMATILLA R	LCOL	RM 73 100% RV CLIP, 10% CWT-AD	
*											LOT ID TOTAL.		100,689	FROM 10 RELEASES				*
	SP CHINOOK	1	6/01/93	6/02/93	667,367	93108	04	LA	5	2	6/01/93	6/01/93	10,372	UMATILLA R	UMATILLA R	LCOL	RM 80 50% LV CWT AD	
							06	LA	5	4	6/01/93	6/01/93	10,139	UMATILLA R	UMATILLA R	LCOL	RM 80 50% LV CWT AD	
							03	RA	5	2	6/01/93	6/01/93	10,035	UMATILLA R	UMATILLA R	LCOL	RM 80 50% LV CWT AD	
							05	RA	5	4	6/01/93	6/01/93	9,961	UMATILLA R	UMATILLA R	LCOL	RM 80 50% LV CWT AD	
							02	LA	5	1	6/02/93	6/02/93	9,127	UMATILLA R	UMATILLA R	LCOL	RM 80 50% LV CWT AD	
							01	RA	5	1	6/02/93	6/02/93	9,137	UMATILLA R	UMATILLA R	LCOL	RM 80 50% LV CWT AD	
*											LOT ID TOTAL.		58,771	FROM 6 RELEASES				
**											HATCHERY TOTAL.		195,082	FROM 92 RELEASES				**
WALLOWA	SU STEELHEAD		4/19/93	4/19/93	495,164	93115	01	LA	J	2	4/19/93	4/19/93	20,510	SPRING CR CHNL	WALLOWA R	SNAK	250 PITS; AD LV CLIP CWT 07-61-06	
							02	RA	J	2	4/19/93	4/19/93	20,735	SPRING CR CHNL	WALLOWA R	SNAK	250 PITS; AD LV CLIP CWT 07-61-07	
*											LOT ID TOTAL.		41,245	FROM 2 RELEASES				
**											HATCHERY TOTAL.		41,245	FROM 2 RELEASES				**
***											AGENCY TOTAL...		480,690	FROM 106 RELEASES				***
UMTR BONIFER	SP CHINOOK	1	4/09/93	4/29/93	85,134	93601	01	LA	RF	1	4/15/93	4/15/93	154	UMATILLA R	UMATILLA R	LCOL		
							04	LA	RN	1	4/15/93	4/28/93	427	UMATILLA R	UMATILLA R	LCOL		
							02	LD	RF	1	4/15/93	4/15/93	149	UMATILLA R	UMATILLA R	LCOL		
							05	LD	RN	1	4/15/93	4/28/93	418	UMATILLA R	UMATILLA R	LCOL		
							03	RA	RF	1	4/15/93	4/15/93	98	UMATILLA R	UMATILLA R	LCOL		
							06	RA	RN	1	4/15/93	4/28/93	405	UMATILLA R	UMATILLA R	LCOL		
							07	RD	RT	1	4/15/93	4/24/93	486	UMATILLA R	UMATILLA R	LCOL		
							08	LA	RF	2	4/16/93	4/16/93	150	UMATILLA R	UMATILLA R	LCOL		
							18	LA	RN	2	4/16/93	4/29/93	371	UMATILLA R	UMATILLA R	LCOL		
							09	LD	RF	2	4/16/93	4/16/93	140	UMATILLA R	UMATILLA R	LCOL		
							19	LD	RN	2	4/16/93	4/29/93	330	UMATILLA R	UMATILLA R	LCOL		
							44	LD	RT	2	4/16/93	4/29/93	173	UMATILLA R	UMATILLA R	LCOL		
							10	RA	RF	2	4/16/93	4/16/93	148	UMATILLA R	UMATILLA R	LCOL		
							11	RA	RN	2	4/16/93	4/29/93	370	UMATILLA R	UMATILLA R	LCOL		
							20	RD	RT	2	4/16/93	4/16/93	426	UMATILLA R	UMATILLA R	LCOL		
							21	LA	RF	3	4/17/93	4/17/93	155	UMATILLA R	UMATILLA R	LCOL		
							14	LA	RN	3	4/17/93	4/17/93	152	UMATILLA R	UMATILLA R	LCOL		
							12	LD	RF	3	4/17/93	4/17/93	147	UMATILLA R	UMATILLA R	LCOL		
							15	LD	RN	3	4/17/93	4/17/93	156	UMATILLA R	UMATILLA R	LCOL		
							13	RA	RF	3	4/17/93	4/17/93	140	UMATILLA R	UMATILLA R	LCOL		
							16	RA	RN	3	4/17/93	4/17/93	155	UMATILLA R	UMATILLA R	LCOL		
							17	RD	RT	3	4/17/93	4/17/93	444	UMATILLA R	UMATILLA R	LCOL		
							25	LA	RF	4	4/23/93	4/23/93	146	UMATILLA R	UMATILLA R	LCOL		
							22	LA	RY	1	4/23/93	4/28/93	433	UMATILLA R	UMATILLA R	LCOL		
							26	LD	RF	4	4/23/93	4/23/93	137	UMATILLA R	UMATILLA R	LCOL		
							23	LD	RY	1	4/23/93	4/28/93	445	UMATILLA R	UMATILLA R	LCOL		
							27	RA	RF	4	4/23/93	4/23/93	150	UMATILLA R	UMATILLA R	LCOL	RM 27	
							24	RA	RY	1	4/23/93	4/28/93	437	UMATILLA R	UMATILLA R	LCOL		
							31	LA	RN	4	4/24/93	4/24/93	140	UMATILLA R	UMATILLA R	LCOL	RM 27	
							28	LA	RY	2	4/24/93	4/29/93	307	UMATILLA R	UMATILLA R	LCOL		
							32	LD	RN	4	4/24/93	4/24/93	148	UMATILLA R	UMATILLA R	LCOL	RM 27	
							29	LD	RY	2	4/24/93	4/29/93	293	UMATILLA R	UMATILLA R	LCOL		

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AGCY HATCHERY.......	SPECIES...	AGE	MAJOR RELEASE START	MAJOR RELEASE STOP	TOTAL NUMBER RELEASED	LOT ID	#	LOC	BRND	ROT	BRAND RELEASE START	BRAND RELEASE STOP	BRAND NUMBER RELEASED	RELEASE SITE...	RIVER NAME	ZONE	COMMENTS................	FPC BRAND
UMTR BONIFER	SP CHINOOK						33	RA	RN	4	4/24/93	4/24/93	146	UMATILLA R	UMATILLA R	LCOL	RM 27	
							30	RA	RY	2	4/24/93	4/29/93	311	UMATILLA R	UMATILLA R	LCOL		
							37	LA	RT	4	4/25/93	4/25/93	140	UMATILLA R	UMATILLA R	LCOL	RM 27	
							34	LA	RY	3	4/25/93	4/25/93	154	UMATILLA R	UMATILLA R	LCOL	RM 27	
							38	LD	RT	4	4/25/93	4/25/93	142	UMATILLA R	UMATILLA R	LCOL	RM 27	
							35	LD	RY	3	4/25/93	4/25/93	169	UMATILLA R	UMATILLA R	LCOL	RM 27	
							39	RA	RT	4	4/25/93	4/25/93	138	UMATILLA R	UMATILLA R	LCOL	RM 27	
							36	RA	RY	3	4/25/93	4/25/93	162	UMATILLA R	UMATILLA R	LCOL	RM 27	
							40	LA	RT	1	4/28/93	4/28/93	277	UMATILLA R	UMATILLA R	LCOL	RM 27	
							41	LD	RT	1	4/28/93	4/28/93	277	UMATILLA R	UMATILLA R	LCOL	RM 27	
							42	RA	RT	1	4/28/93	4/28/93	277	UMATILLA R	UMATILLA R	LCOL	RM 27	
							43	LA	RT	2	4/29/93	4/29/93	162	UMATILLA R	UMATILLA R	LCOL		
*							45	RA	RT	2	4/29/93	4/29/93	184	UMATILLA R	UMATILLA R	LCOL		
											LOT ID TOTAL.		10,769	FROM 45 RELEASES				.
UMTR BONIFER	SU STEELHEAD		4/18/93	5/13/93	110,289	93602	03	RA	B	3	4/18/93	4/18/93	8,860	BONIFER	UMATILLA R	LCOL	RM 79, 100% AD CLIP 7762 CWT-LV	
							02	LA	B	1	5/13/93	5/13/93	9,042	BONIFER	UMATILLA R	LCOL	RM 79, 100% AD CLIP 6920 CWT-LV	
*											LOT ID TOTAL.		17,902	FROM 2 RELEASES				.
	SU STEELHEAD		4/19/93	4/19/93	47,979	93603	01	RA	B	1	4/19/93	4/19/93	9,637	MINTHORN	UMATILLA R	LCOL	RM 65, 100% AD CLIP 6550 CWT-LV	
*											LOT ID TOTAL.		9,637	FROM 1 RELEASES				.
**											HATCHERY TOTAL.		38,308	FROM 48 RELEASES				..
***											AGENCY TOTAL...		38,308	FROM 48 RELEASES				.
USFW DWORSHAK	SU STEELHEAD		4/19/93	4/23/93	739,629	93232	01	RA	R	2	4/19/93	4/23/93	21,000	S F CLEARWATER	S F CLEARWATER	SNAK	SPORT HARVEST MARK	.
*											LOT ID TOTAL.		21,000	FROM 1 RELEASES				
	SU STEELHEAD		5/03/93	5/04/93	1,217,990	93204	03	LD	R	1	5/03/93	5/04/93	10,000	DWORSHAK	N F CLEARWATER	SNAK	SYS. 1 CONTRIB.	.
							04	LD	R	3	5/03/93	5/04/93	10,000	DWORSHAK	N F CLEARWATER	SNAK	EARLY RTN PROGENY	
							01	RD	R	1	5/03/93	5/04/93	10,000	DWORSHAK	N F CLEARWATER	SNAK	SYS. 2 CONTRIB.	
							02	RD	R	3	5/03/93	5/04/93	10,000	DWORSHAK	N F CLEARWATER	SNAK	SYS. 3 CONTRIB.	.
*											LOT ID TOTAL.		40,000	FROM 4 RELEASES				
**											HATCHERY TOTAL.		61,000	FROM 5 RELEASES				.
NON-HATCHERY	FA CHINOOK	0	6/24/93	8/10/93	108,449	93299	01	RA	W	1	6/24/93	6/24/93	5,374	BELOW MCN DAM	LOWER COLUMBIA	LCOL	CWT 05-33-18	
							02	RA	W	2	6/25/93	6/25/93	3,706	BELOW MCN DAM	LOWER COLUMBIA	LCOL	CWT 05-33-18	
							03	RA	W	3	6/26/93	6/26/93	2,792	BELOW MCN DAM	LOWER COLUMBIA	LCOL	CWT 05-33-18	
							04	RA	W	4	6/27/93	6/27/93	4,647	BELOW MCN DAM	LOWER COLUMBIA	LCOL	CWT 05-33-19	
							05	LA	W	1	6/28/93	6/28/93	4,405	BELOW MCN DAM	LOWER COLUMBIA	LCOL	CWT 05-33-19	
							06	LA	W	2	6/29/93	6/29/93	2,975	BELOW MCN DAM	LOWER COLUMBIA	LCOL	CWT 05-33-19	
							07	LA	W	3	6/30/93	6/30/93	4,635	BELOW MCN DAM	LOWER COLUMBIA	LCOL	CWT 05-33-20	
							08	LA	W	4	7/01/93	7/01/93	3,349	BELOW MCN DAM	LOWER COLUMBIA	LCOL	CWT 05-33-20	
							09	RA	2J	1	7/02/93	7/02/93	4,061	BELOW MCN DAM	LOWER COLUMBIA	LCOL	CWT 05-33-20	
							13	RA	2T	1	7/09/93	7/09/93	3,249	BELOW MCN DAM	LOWER COLUMBIA	LCOL	CWT 05-33-21	
							14	RA	2T	3	7/10/93	7/10/93	5,202	BELOW MCN DAM	LOWER COLUMBIA	LCOL	CWT 05-33-21	
							15	LA	2T	1	7/11/93	7/11/93	3,428	BELOW MCN DAM	LOWER COLUMBIA	LCOL	CWT 05-33-21	
							16	LA	2T	3	7/12/93	7/12/93	2,811	BELOW MCN DAM	LOWER COLUMBIA	LCOL	CWT 05-33-22	
							17	RA	2P	1	7/13/93	7/13/93	5,176	BELOW MCN DAM	LOWER COLUMBIA	LCOL	CWT 05-33-22	
							18	RA	2P	3	7/14/93	7/14/93	3,871	BELOW MCN DAM	LOWER COLUMBIA	LCOL	CWT 05-33-22	
							19	LA	2P	1	7/15/93	7/15/93	3,228	BELOW MCN DAM	LOWER COLUMBIA	LCOL	CWT 05-33-23	
							20	LA	2P	3	7/16/93	7/16/93	3,752	BELOW MCN DAM	LOWER COLUMBIA	LCOL	CWT 05-33-23	
							21	RA	9U	1	7/17/93	7/17/93	2,662	BELOW MCN DAM	LOWER COLUMBIA	LCOL	CWT 05-33-23	
							22	RA	9U	3	7/18/93	7/18/93	2,177	BELOW MCN DAM	LOWER COLUMBIA	LCOL	CWT 05-33-23	
							25	RA	2V	1	7/27/93	7/27/93	3,365	BELOW MCN DAM	LOWER COLUMBIA	LCOL	CWT 05-33-24	
							26	RA	2V	3	7/28/93	7/28/93	5,451	BELOW MCN DAM	LOWER COLUMBIA	LCOL	CWT 05-33-24	
							36	LA	2V	1	7/29/93	7/29/93	2,982	BELOW MCN DAM	LOWER COLUMBIA	LCOL	CWT 05-33-24	
							27	LA	2V	3	7/30/93	7/30/93	982	BELOW MCN DAM	LOWER COLUMBIA	LCOL	CWT 05-33-25	
							28	RA	2L	1	7/31/93	7/31/93	6,003	BELOW MCN DAM	LOWER COLUMBIA	LCOL	CWT 05-33-25	
							29	RA	2L	3	8/01/93	8/01/93	4,865	BELOW MCN DAM	LOWER COLUMBIA	LCOL	CWT 05-33-25	
							30	LA	2L	1	8/02/93	8/02/93	5,251	BELOW MCN DAM	LOWER COLUMBIA	LCOL	CWT 05-33-26	
							31	LA	2L	3	8/03/93	8/03/93	3,649	BELOW MCN DAM	LOWER COLUMBIA	LCOL	CWT 05-33-26	
*							32	RA	2C	1	8/04/93	8/04/93	3,030	BELOW MCN DAM	LOWER COLUMBIA	LCOL	CWT 05-33-26	
**											LOT ID TOTAL.		107,078	FROM 28 RELEASES				.
***											HATCHERY TOTAL.		107,078	FROM 28 RELEASES				..
											AGENCY TOTAL...		168,078	FROM 33 RELEASES				..

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AGCY	HATCHERY.......	SPECIES...	AGE	MAJOR RELEASE START	MAJOR RELEASE STOP	TOTAL NUMBER RELEASED	LOT ID	#	LOC	BRND	ROT	BRAND RELEASE START	BRAND RELEASE STOP	BRAND NUMBER RELEASED	RELEASE SITE...	RIVER .... NAME	ZONE	COMMENTS................	FPC BRAND
~~WDF~~	~~PRIEST RAPIDS~~	~~FA CHINOOK~~	~~0~~	~~6/15/93~~	~~6/27/93~~	~~6,386,000~~	~~93041~~	01	LA	U	2	6/15/93	6/15/93	32,042	BELOW PRD DAM	MID COLUMBIA R	MCOL	L WHITE SALMON STOCK	
								05	LA	U	1	6/18/93	6/18/93	42,075	BELOW PRD DAM	MID COLUMBIA R	MCOL		
								04	LD	U	1	6/21/93	6/21/93	42,182	BELOW PRD DAM	MID COLUMBIA R	MCOL		
								02	LA	U	3	6/24/93	6/24/93	42,160	BELOW PRD DAM	MID COLUMBIA R	MCOL		
								03	LD	U	3	6/27/93	6/27/93	42,010	BELOW PRD DAM	MID COLUMBIA R	MCOL		
*												LOT ID TOTAL.		200,469	FROM 5 RELEASES				*
**												HATCHERY TOTAL.		200,469	FROM 5 RELEASES				**
	RINGOLD	SP CHINOOK	1	4/01/93	4/04/93	669,400	93040	02	LA	7T	1	4/01/93	4/04/93	13,500	RINGOLD	MID COLUMBIA R	MCOL	CARSON STOCK	
								01	RA	7T	1	4/01/93	4/04/93	14,000	RINGOLD	MID COLUMBIA R	MCOL	RINGOLD STOCK	
								03	RA	7T	3	4/01/93	4/04/93	13,600	RINGOLD	MID COLUMBIA R	MCOL	KALAMA STOCK	
*												LOT ID TOTAL.		41,100	FROM 3 RELEASES				*
**												HATCHERY TOTAL.		41,100	FROM 3 RELEASES				**
***												AGENCY TOTAL...		241,569	FROM 8 RELEASES				***
WDW	LYONS FERRY	SU STEELHEAD		4/03/93	4/30/93	113,539	93413	03	RA	IC	1	4/03/93	4/30/93	30,035	TUCANNON R	TUCANNON R	SNAK	LV/CWT; RELEASED @ CURL LAKE	
								01	LA	IC	1	4/20/93	4/22/93	30,221	TUCANNON R	TUCANNON R	SNAK	LV/CWT; DIRECT STREAM RELEASE @ CURL LAKE	
								02	LA	IC	3	4/20/93	4/22/93	30,031	TUCANNON R	TUCANNON R	SNAK	LV/CWT; DIRECT STREAM RELEASE @ MARENGO	
*												LOT ID TOTAL.		90,287	FROM 3 RELEASES				*
		SU STEELHEAD		4/16/93	4/23/93	83,240	93415	01	LA	H	1	4/16/93	4/16/93	20,138	WALLA WALLA R	WALLA WALLA R	MCOL	LV/CWT	
								02	LA	H	2	4/16/93	4/16/93	20,339	WALLA WALLA R	WALLA WALLA R	MCOL	LV/CWT	
*												LOT ID TOTAL.		40,477	FROM 2 RELEASES				*
		SU STEELHEAD		4/24/93	4/30/93	110,999	93416	01	RA	H	1	4/24/93	4/30/93	20,328	TOUCHET R	WALLA WALLA R	MCOL	LV/CWT	
								02	RA	H	2	4/24/93	4/30/93	20,104	TOUCHET R	WALLA WALLA R	MCOL	LV/CWT	
*												LOT ID TOTAL.		40,432	FROM 2 RELEASES				*
**												HATCHERY TOTAL.		171,196	FROM 7 RELEASES				**
***												AGENCY TOTAL...		171,196	FROM 7 RELEASES				***

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* L A S T P A G E *
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Appendix **H:**

Dissolved Gas Saturation and Gas Bubble Trauma
in Juvenile Fish at **Smolt** Monitoring Sites

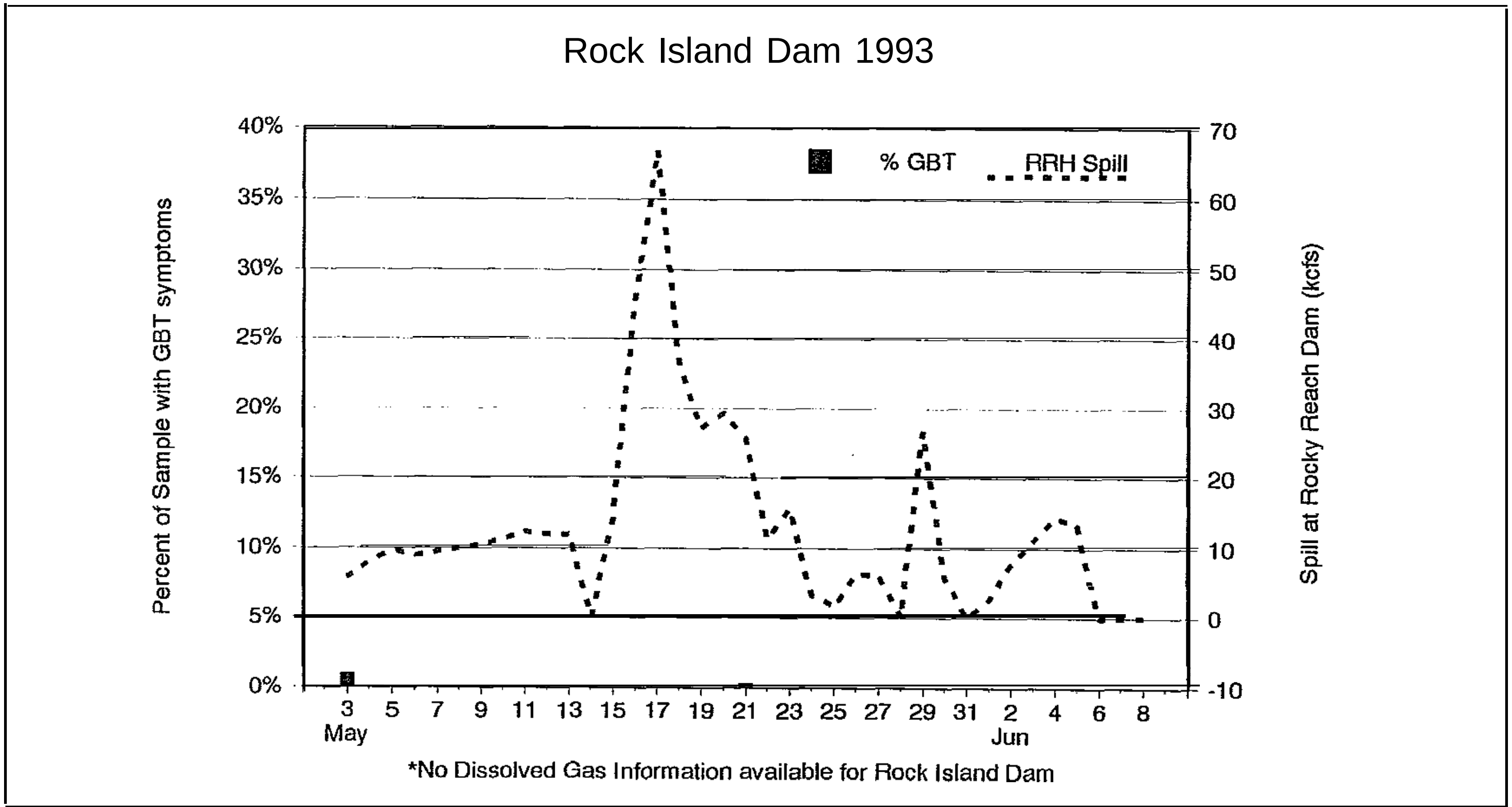

Figure 1. Rock Island Dam
Fish were observed with GBT symptoms on 2 days at Rock Island Dam, on May 3 (2% of sockeye, or 1% of the sample) and on May 21 (1.2% of chinook, or 0.4% of the sample). No dissolved gas saturation information is available for Rock Island for May. The observations of GBT on May 3 are not likely a result of ambient river conditions, since dissolved gas levels around that time at Wells, Chief Joseph and Grand Coulee dams varied between 103 and 109%, and spill at Rocky Reach Dam was low in early May (6-8 kcfs). Spill at Rocky Reach was higher around May 21, with a peak daily average of 67 kcfs on May 17, and levels of about 30 kcfs the few days afterward.

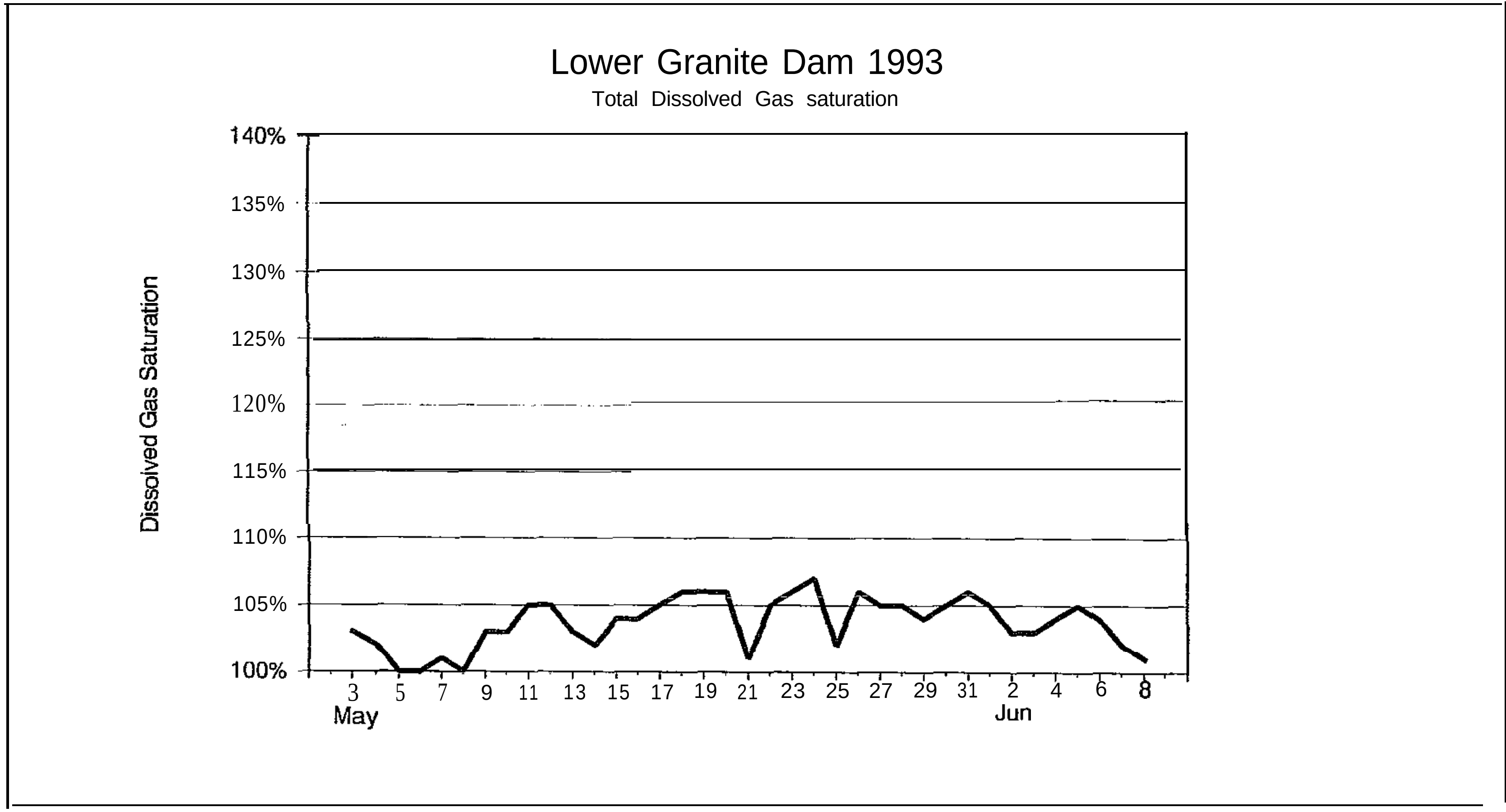

Figure 2. Lower Granite Dam
No observations of GBT symptoms.

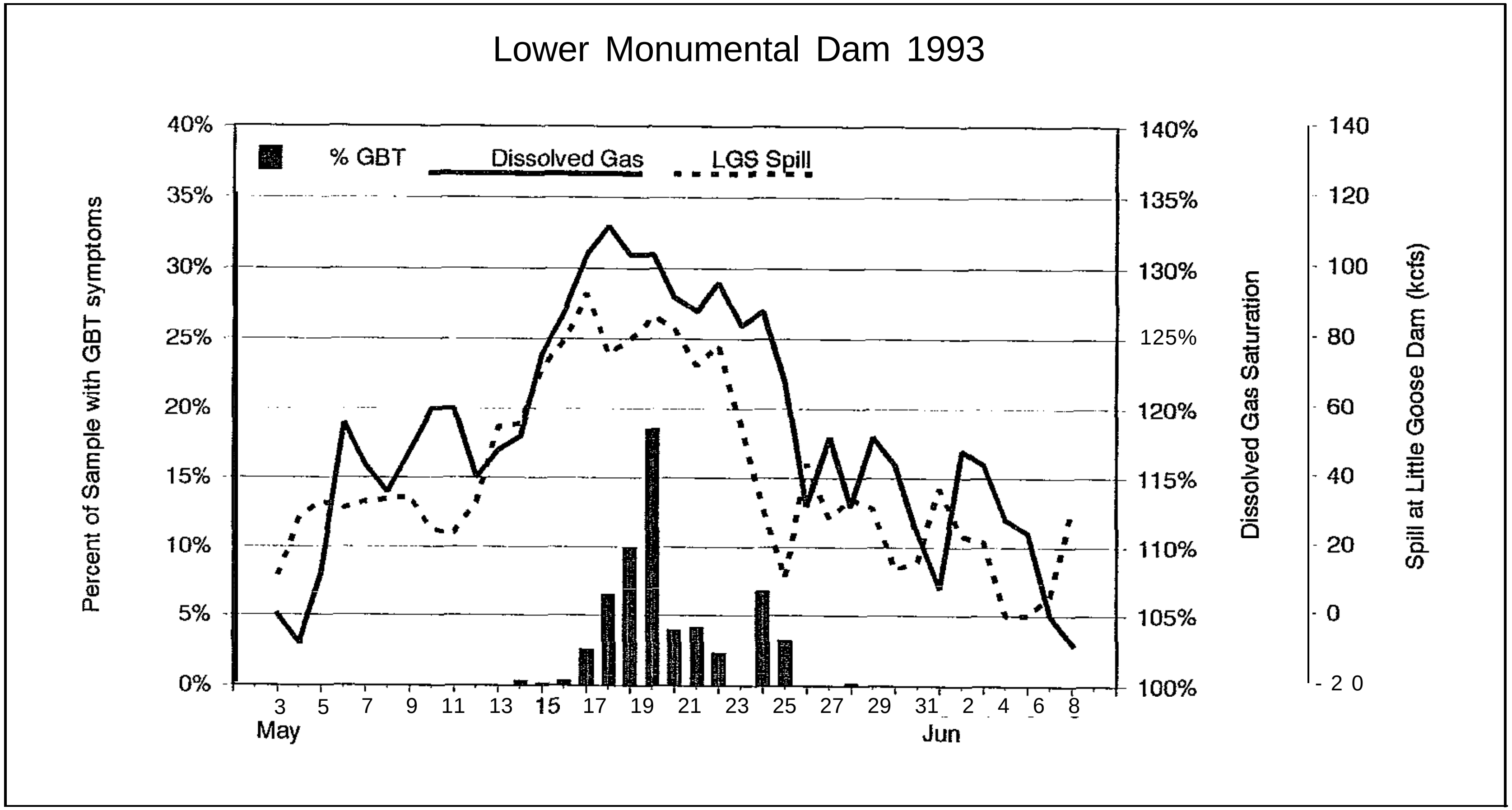

Figure 3. Lower Monumental Dam

The highest percentages of the sample with GBT throughout the entire system were observed at Lower Monumental Dam, with a peak of 18.6% of the sample on May 20. Lower Monumental Dam also had some of the highest dissolved gas levels of any of the monitoring sites, exceeding 130% for 4 days beginning May 17. GBT symptoms were first seen on May 14, and last seen on May 29. The most frequent category of GBT symptoms observed were bubbles in less than 50% of the caudal fin. The second most common type were observations of bubbles in the caudal and other tins, and the least frequent were observations of bubbles in greater than 50% of the caudal fin. Two wild steelhead sampled on May 16 had severe symptoms of GBT. Symptoms were seen in steelhead (highs of 18% and 19% for hatchery and wild, respectively), chinook yearlings (daily maximums of 15% for hatchery and 12.5% for wild), and a few sockeye. Operations limitations at Little Goose Dam during the period of peak flows contributed to the dissolved gas problems at Lower Monumental Dam. Two units were out of service for FGE testing, which reduced the hydraulic capacity of the dam and forced more spill. In addition, one spillbay equipped with a flip lip was unusable because of research equipment installed in it for NMFS survival study purposes. This caused proportionately more spill to pass through the spillbays without flip lips and concentrated the spill into a smaller area, which likely resulted in higher dissolved gas levels than if all the spillbays had been usable. Spill levels at Little Goose during the period when GBT was observed ranged from a daily average of 10.8 to 92.9 kcfs, and averaged 61.4 kcfs.

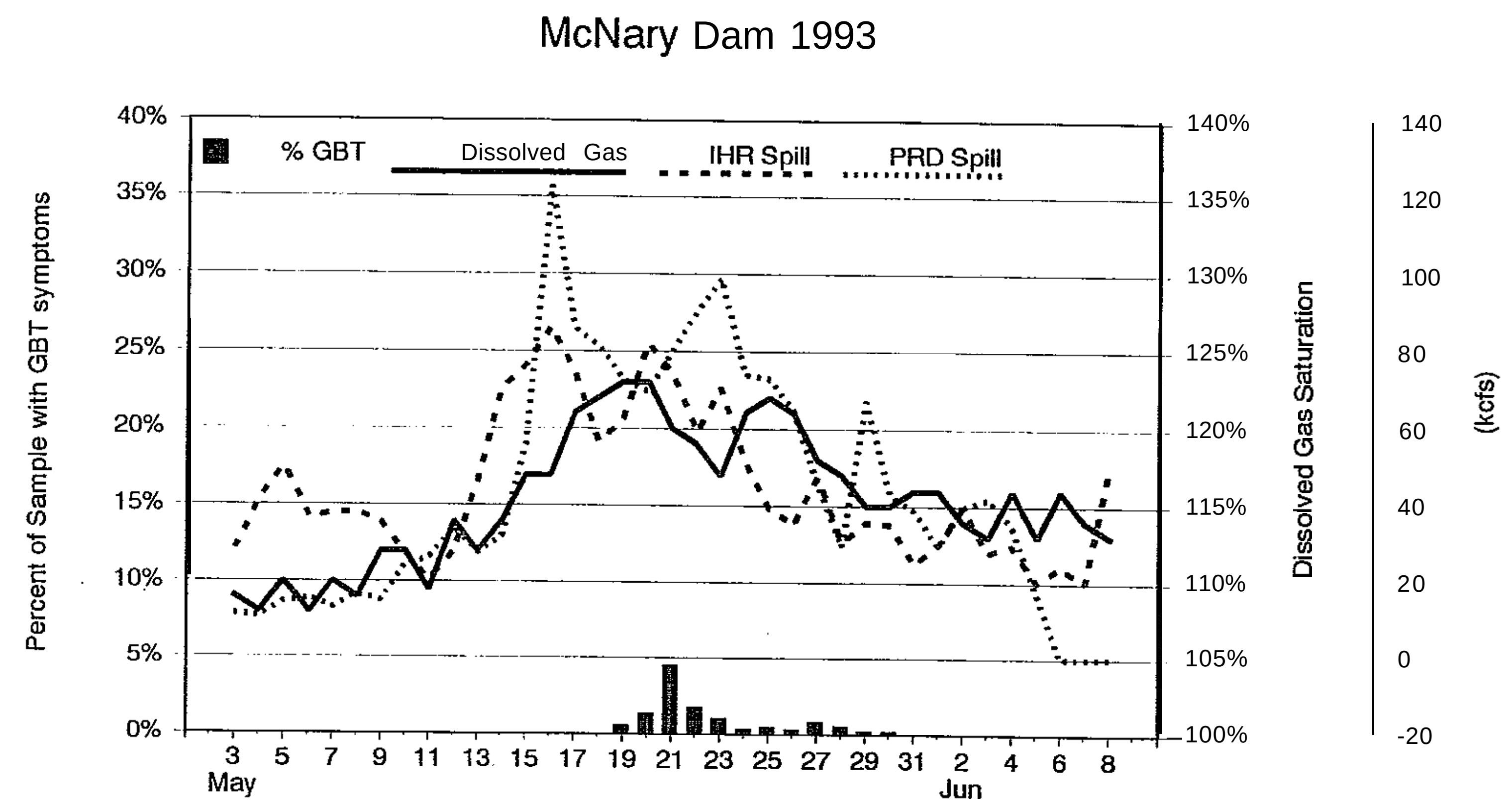

Figure 4. **McNary** Dam

Low incidence of GBT symptomatic fish was seen May 19 through May 3 1 at McNary Dam. Daily incidence varied from 0.1% of the sample to 4.6% of the sample on May 21. The daily average dissolved gas high during this period was 123% for two days, May 19 and 20. Spill at Ice Harbor during the period when fish were affected ranged from around 30 to over 80 kcfs; spill at Priest Rapids Dam was mostly over 80 kcfs during the time when the highest frequencies of GBT symptomatic fish were seen. The most frequent category of GBT symptoms observed were bubbles in less than 50% of the caudal fin. The second most common type were observations of bubbles of bubbles in greater than 50% of the caudal fin, and the least frequent were observations in the caudal and other tins. Symptoms were seen in steelhead (highs of 8% and 14% for hatchery and wild, respectively), coho (maximum 7%), sockeye (maximums of 9% and 2% for hatchery and wild, respectively) and chinook yearlings (maximum 5% of daily sample).

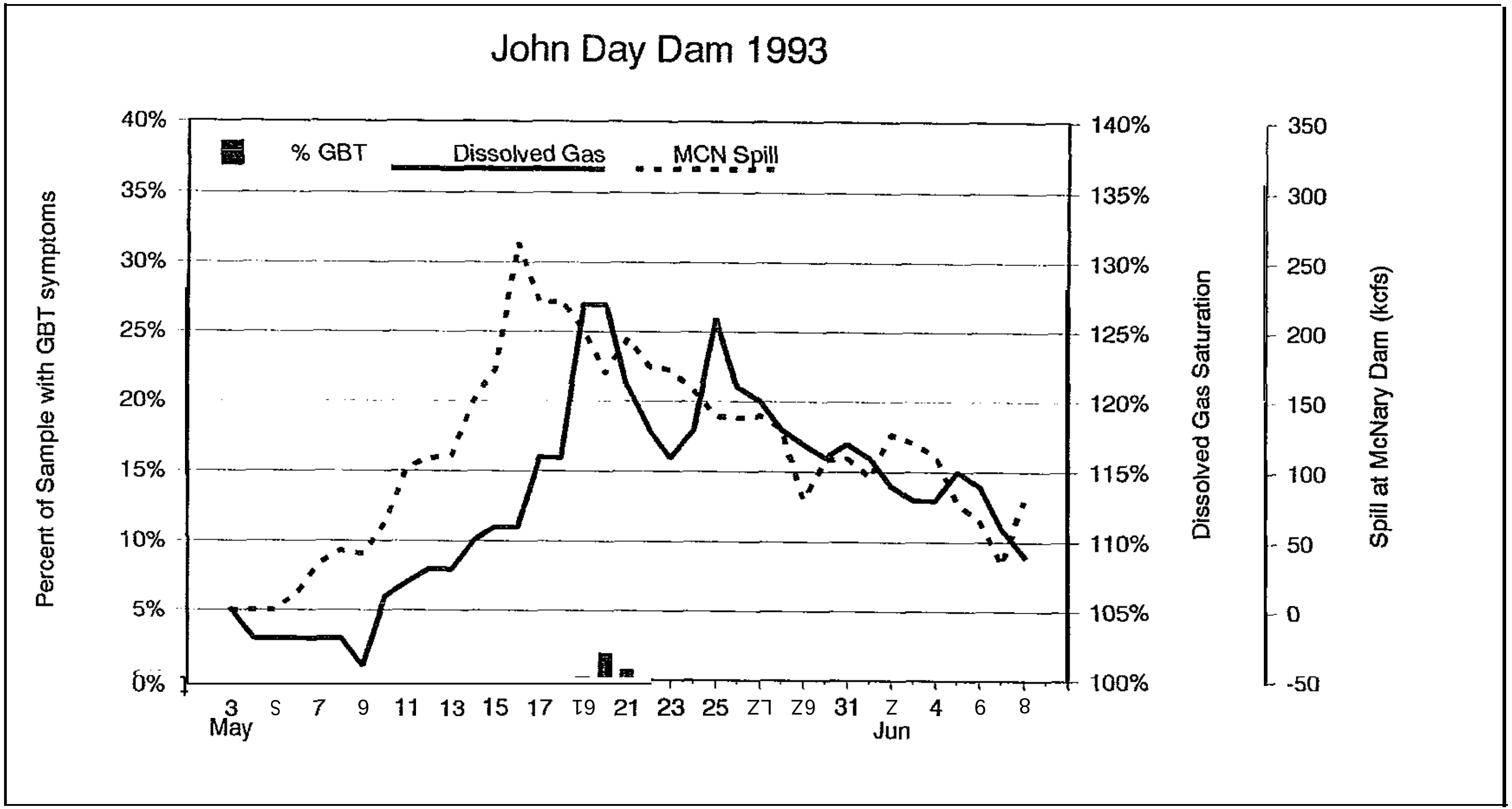

Figure 5. John Day Dam

Low incidence of GBT symptoms was observed on 5 days at John Day Dam, May 19-21, when several fish were observed with symptoms, and on May 27 and 31, when one steelhead was seen with signs of GBT each day. The peak was 2% of the sample on May 20. Dissolved gas daily average saturations on May 19-21 were 127%, 127% and 121%, up from daily averages of 108% to 116% the preceding several days. Signs of GBT were most often observed in steelhead; the peak daily percentage of steelhead with GBT was 3%. GBT was also observed in chinook and coho (1% each on May 20).

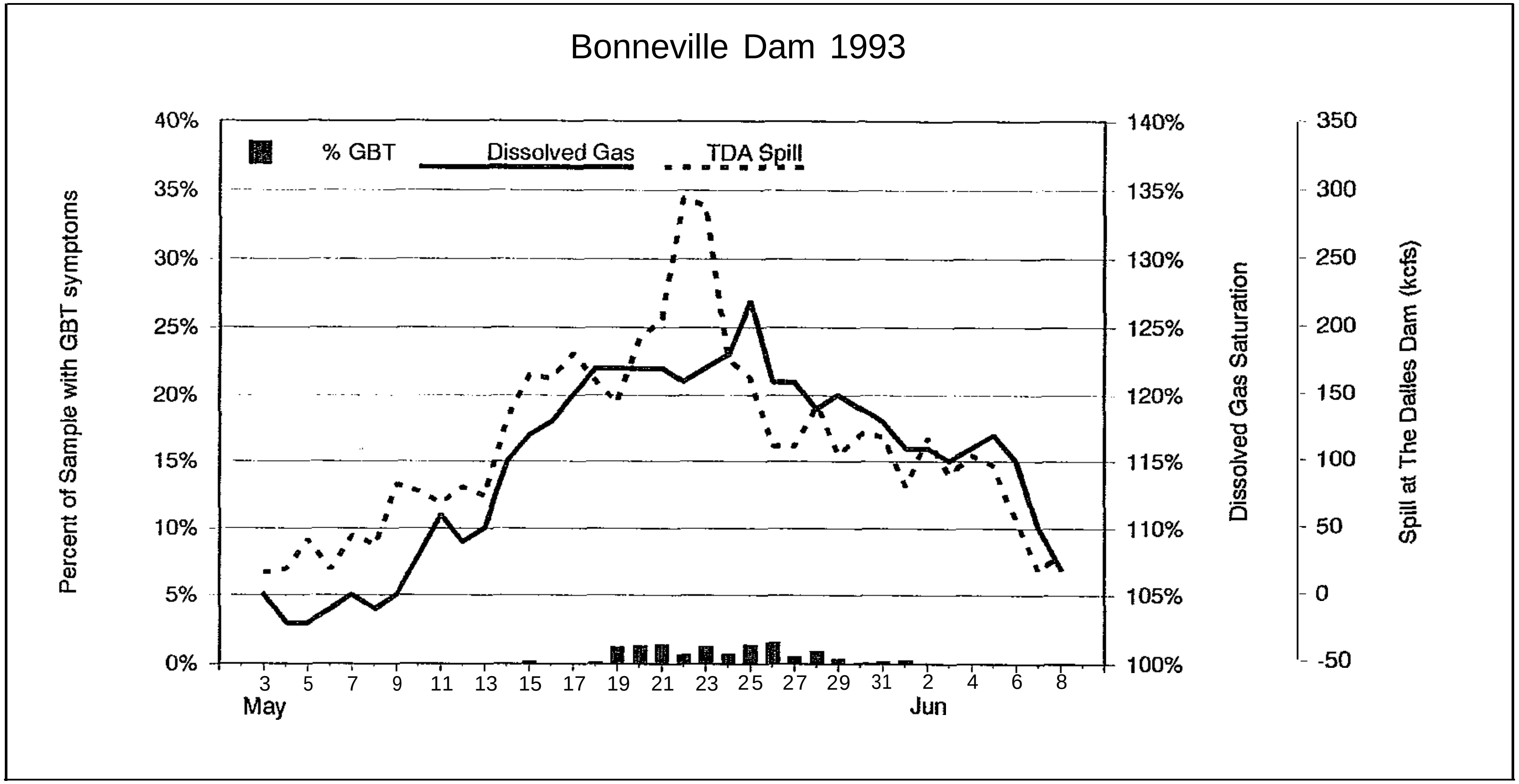

Figure 6. Bonneville Dam

Low incidence of GBT symptoms in fish was observed on 19 days during the period beginning May 15 and ending June 8. This comprised the longest time span over which GBT observations were made at any monitoring site. The highest percentage of the daily sample with evidence of GBT was 1.6% on May 26. Daily average dissolved gas saturation during the period when most GBT symptoms were seen were above 120%; the high was 127%. GBT was seen mostly in steelhead (daily highs of 8% and 11% for hatchery and wild, respectively), sometimes in coho (maximum of 3%), less often in chinook yearlings and sockeye (1% of sample or less), and almost never in chinook subyearlings. Bonneville was the only site that observed GBT symptoms in subyearlings at all.

Below Bonneville:

The National Marine Fisheries Service reported that 24 salmon and steelhead were observed with mild symptoms of GBT below Bonneville Dam out of 1,863 sampled from May 6 to June 16. A similar proportion of other species sampled were observed to be affected. Two out of 26 coho with bubbles in less than 50% of the caudal fin were sampled at the Rooster Rock station (RM 130) on May 19. 11 out of 17 coho sampled at the Rooster Rock station (RM 130) on May 21 had bubbles in the anal fin, and 2 out of the 17 had bubbles in less than 50% of the caudal and anal tins. Also on May 21, 1 out of 68 chinook and the only coho sampled at the Lemon Island station (RM 111.8) had anal tin bubbles. 1 out of 102 chinook, the only coho, and 1 out of 35 peamouth sampled at the Puget Island station (RM 46.3) on May 22 had bubbles in their anal fins. On May 25, at Rooster Rock, 2 out of 4 coho and 1 out of 5 steelhead sampled had bubbles in the anal fm. 2 out of 7 coho sampled at the Hump Island station (RM 59.7) on June 9 had signs of GBT; one had bubbles in the anal tin and the other had bubbles in less than 50% of the caudal fin. Three non-salmonids were also observed to have evidence of GBT, out of approximately 1,500 sampled. On June 1, one out of 24 sculpin sampled at the Beacon Rock station (RM 142) had bubbles in the eye and 2 out of 12 stickleback had bubbles on the posterior half of the body on the side above the lateral line.

Appendix I:

Response to BPA Comments on the Draft 1993 Annual Report

FISH PASSAGE CENTER
2501 S.W. FIRST AVE. • SUITE 230 • PORTLAND, OR 97201-4752
PHONE (503) 230-4099 • FAX (503) 230-7559

March 30. 1994

Sharron A. Monohon
Bonneville Power Administration
P.O. Box 3621 - PJI
Portland. OR 97208-3621

Dear Ms. Monohon:

We have received your comments on the draft 1993 Fish Passage Center Annual Report. We have carefully considered and addressed each of your comments. identifying the heading and number of each with each of our responses. As you requested. we have attached your comments to the final report in Appendix I.

General Comments:

3. We appreciate BPA's sensitivities towards certain observations regarding conflicts, policies, management procedures and regional policies that occurred during the passage season. However, we view the identification of these issues in the Fish Passage Center Annual Report as a critical component to the eventual resolution of these problems. In addition, the Fish Passage Center (FPC) operates under the auspices of all of the state, federal and tribal resource managers and is therefore bound to report these issues on their behalf. This is particularly important because the FPC Annual Report is widely distributed and a source of information for the public at large.

4. Your comments state that until direct measures of survival are available. the benefits of flow can not be determined. You further state that the occurrence of better migration conditions occurring in 1993 that 1992 is "only our opinion". This is incorrect. Our conclusion and the conclusion of the state. federal and tribal fishery resource managers. is that migration conditions were better in 1993 than 1992. and is based upon the large volume of data in the FPC Annual Report, including travel time. passage timing distribution. proportion of marks recaptured. hatchery production to passage index ratio. and ten years of historic data. We understand BPA's sensitivity to an observation that the 1993 migrants experienced better conditions than 1992 migrants. However, the data and analysis are clear and indisputable.

   Your comments regarding benefits of flow and direct measures of juvenile survival estimates are incorrect. The present studies will develop survival estimates, but the effect of flow on that survival estimate will not be separable from all of the other factors resulting in a survival estimate. This was pointed out to BPA by the Scientific Review Group. In addition, individual reach survival estimates for juvenile migrants do not provide any insight into successful migration through downstream reaches or contribution to adult returns. The first year of survival studies produced results that were within the range of those predicted. utilizing the present historic data. We believe that each subsequent year will produce similar results within those ranges. We suggest that BPA review the actual application of the results of these studies to resolution of management problems. The present efforts to develop juvenile survival estimates will not elucidate or provide definitive criteria for determination of quality of the migration condition. It is simply one additional factor to consider along with the data presently being collected. We ore concerned that BPA's intent in this comment is to diminish or color the actual data and indices that characterize the juvenile migrations.

3. The discussion of the EPA dissolved gas standard is completely appropriate because it was a central issue in the discussions that took place during the migration season. The FPC Annual Report reflects the actual problems. issues and actions that have taken place during the migration season as well as reporting the migration characteristics of a particular year. Once again we must state that ignoring conflicts and problems does not lead to their resolution.

6. The goal of dissolved gas and Gas Bubble Trauma (GBT) monitoring efforts in 1993 was not to definitively quantify the impacts of dissolved gas supersaturation on fish, but rather to provide managers with some baseline information useful in judging whether a problem exists and estimating the severity of any impacts. Reservoir monitoring was conducted below Bonneville Dam by the National Marine Fisheries Service. Even without systematic reservoir monitoring, monitoring of the populations passing dams is a useful tool in determining the existence and severity of impacts of dissolved gas supersaturation. The results of research indicate that whenever there is significant mortality due to exposure to dissolved gas supersaturation, a proportion of the fish will exhibit external symptoms of GBT. The symptoms and progression of GBT are well documented. In acutely lethal situations. fish that succumb in a short time usually do not exhibit external GBT symptoms. However. several environmental and behavioral factors combine to increase the likelihood that populations of adult and juvenile migrants do not encounter uniform conditions in the river. This leads us to expect that any time dissolved gas levels are high enough to cause an acutely lethal situation. a proportion of the fish will survive or experience a Lesser degree of exposure and are likely to exhibit external symptoms.

7. Section III of the FPC Annual Report refers to spill programs at the mainstem projects. In the 1992 NMFS Biological Opinion the spill program was established to achieve approximately the 70/50 Fish Passage Efficiency objective at Ice Harbor Dam (1992 Biological Opinion, page 9). In 1993 spill at Ice Harbor was initially established at the levels described in the COE's Juvenile Fish Passage Plan which establishes a 70/50 objective (page 1), until the 1993 Opinion was released. The 1993 spill program for 1993 was interrupted and reestablished at a lower level by NMFS. BPA and the COE on April 16, 1993. An interim program was established until the 1993 Biological Opinion was released. This sequence of events is accurately depicted in the text of the report, and the word "approximately" has been added to modify the 70/50.

8-11. The final report presents more multi-variable regression analyses than were available at the time of the writing of the draft report. In selecting additional variables for modelling, we chose among flow-related and smoitification-related factors. In the 1993 FPC Annual Report. the flow-related factor is flow averaged over the time spanned by the travel time estimate. The smoltification-related factors include date of release. water temperature either at release or averaged over travel time period, and race. Date of release and water temperature are generally highly correlated. but both functioning as surrogates for the trend toward higher levels of smoltification in the run over time. Models for subyearling and yearling chinook and sockeye typically have both flow-related and smoltificarion-related factors. while those for steelhead typically have an overriding flow effect. Plots of the, transformed variables and of the residuals from the regressions presented in this report were viewed in SYSTAT's SYGRAPH. and were useful in developing the final models. However. we do not feel that an appendix of these plots are necessary for this Annual Report. The regression coefficients and P-values are shown in tables in the final report. Description of significance levels were added to the methods section of Chapter IV. When a relation is reported as significant. it refers to $P \leq 0.05$. When helpful for clarity, significance values are also presented in the text. Descriptive comparisons of 1993 data to 1992 data occurs in the text whenever needed to make a point about a high flow vs low flow condition. But for the statistical analysis. the complete series of years available are used. which typically is 5 to 8 years for travel time relations.

Responses bv Chapter:

Chapter II: 1993 Operations

1. The Pacific Northwest Coordination Agreement annual planning (§6.b) does generate a final regulation which includes a set of reservoir rule curves for the critical years as well as flows necessary to meet electric loads. While these flows and elevations are not cast in stone. the fact remains that the hydropower system operations are roughly planned 6 months in advance of planning for flow augmentation. Furthermore. fall and winter hydropower operations can and do impact spring operations.

2. The period of average is 1961 to 1990.

3. Typographical error, the correct table number is 2.

4. The information does not belong in the Water Supply Section and has been moved to section C.2. However. the FPC Annual Report contains historic narrative along with technical data. We feel it is important to document the low flows that impacted early migrants through the mid-Columbia reach as well as the reasons for the low flows.

5. As we indicated in our cover letter to you, this was a rough draft because of the December 31 deadline. The final report will have improved graphs.

6. BPA's loose usage of the word drought to describe the situation in the Pacific Northwest is strictly qualitative and has no quantitative meaning. For the 1992-1993 Water Year. the Snake River above Ice Harbor Dam had 115% of average precipitation (1961-1990) while Lower Granite inflow for the January-July period was 90% of the 1961-1990 average. With no pre-knowledge of the 1994 runoff, it can not be conclusively stated that the dry cycle in the Snake basin is or is not over.

7. The sentence has been changed from "Despite the. .." to "While.. ."

Chapter III: Spill Implementation

1. The methods for the dissolved gas monitoring program are contained in the annual proposal for the Smolt Monitoring Program which is submitted to BPA. It would be redundant to include all rhe methods associated with the Smolt Monitoring program in this document.

2. The Fish Passage Center is responsible for the implementation of the annual fish program as determined by the fishery agencies and Indian tribes. The agencies and tribes recommended that rhe FPC request the implementation of an 80/70 FPE spill program. which complemented the no transport option. This paragraph simply reflects the objectives of the agencies and tribes and set the stage for the context within which the FPC made spill requests for the agencies and tribes.

3. The definition of overgeneration spill as we understand is spill that occurs because of an inability to market the generation available. This definition has been inserted in the text. The 1993 operations did in general follow the modified spill priority documents and the FPC Annual Report never states differently. The load distribution problems referred to are those that occurred during light load periods. such as weekends when most spill occurred in the Snake.

4. Spill implemenrarion for 1993 was defined for the FPC under the direction of the CBFWA agency and tribal members. With regard to this the standards guided the requests submitted by the FPC. This is neither editorial or political in nature. but merely a recounting of the spill program implemented in 1993 relative to the program recommended for implementation by CBFWA.

5. We do not agree with BPA that this is an "unprofessional sentence", it is simply a statement of the facts. The 1993 Biological Opinion. page 6 states that "The fundamental spill for Ice Harbor Dam is set at 2.5 kcfs from 1800-0600 hours, from April 15 until an analysis of dissolved gas levels and fish condition can be completed by the BPA, COE and NMFS. This analysis is to be completed before May 31, 1993." The implication was that the spill program was only to last until a more detailed look could be accomplished regarding the impact of increased dissolved gas levels on the migrating population. The Biological Opinion fundamental spill program remained in place throughout the season. despite repeated requests for the analysis and for the program to be altered. The language has been reworded.

6. Graphs have been incorporated in an appendix.

7. Monitoring resident fish populations is outside the scope of the Smolt Monitoring Program. Monitoring conducted by the National Marine Fisheries Service below Bonneville Dam in 1993 included resident species and invertebrates.

8. Incorporated.

9. Incorporated.

10. We believe that discussing dissolved gas supersaturation in terms of daily averages is appropriate, Describing dissolved gas conditions in terms of extremes represented by single instantaneous readings is not as informative for this type of general discussion, given that the impacts of dissolved gas supersaturation salmonids are highly dependent on exposure time and fish survival increases with intermittent over constant exposure to high dissolved gas levels. Even at very high levels of saturation, the development of GBT is on the order of many hours to days.

11. We disagree for reasons described in the response to general comment #6. There was no evidence from the observations of either the Smolt Monitoring Program or of the National Marine Fisheries Service of significant dissolved gas related mortality.

12. Clarified.

13. Clarified. GBT is not defined by either internal or external symptoms alone. The presence of external symptoms in a population have been found to be a reasonable indicator of the presence of GBT in a population. For obvious reasons, monitoring fish for internal signs of GBT is not practicable. Furthermore, there is no evidence to suggest that the development of either internal or external symptoms precedes the other.

14. See response to 7) in this section

15. Clarified.

16. The use of GBT in place of GBD is not only more accurate. but increasing in usage in this region. For consistency, we are electing to use the term GBT.

17. Clarified. Also see response to 13) in this section.

18. What we mean by "mild" is explicitly stated here

19. We are unaware of any further observations or investigations regarding the five dead steelhead observed by Larry Basham.

20. The referenced paragraph illustrates the point you make in this comment. For the complete methods and results of the sampling below Bonneville Dam in 1993, contact the National Marine Fisheries Service. The work was not contracted under the Smolt Monitoring Program. and it is inappropriate to include a detailed discussion in this report.

21. We are electing not to include referenced documents in this report in order to keep its length within reasonable bounds. Please contact us directly for copies of referenced documents.

22. The statements referenced are factual and require no clarification.

23. The hypotheses put forward in this comment are speculative, and therefore inappropriate to include in this section.

24. Incorporated.

25. To our knowledge, neither the National Academy of Sciences nor the EPA has undertaken a review of the 110% dissolved gas standard in the Columbia River Basin.

26. Incorporated.

27. See response to 13) in this section. In addition, the considerations involved in the formation of the agency and tribal recommendations with regard to spill have a broader scope than this comment reflects.

28. Comment is not specific.

29. Incorporated.

30. Not incorporated.

31. We are unaware of literature describing the "cascading bubble effect". The referenced sentence is factual and needs no qualification.

32. Incorporated.

33. See response to number 7 in this section.

Chapter IV: 1993 Smolt Monitoring Program

1. In prior years through 1991, IDFG made marked releases for trap efficiency determination. For traps on both the Clearwater and Snake rivers, the trap efficiency data showed that, on average, around 1-2% of yearling chinook and less than 1% of the hatchery steelhead are being collected (Buettner 1991). Because of the desire to collect fish over as wide a range of flows as possible for PIT tagging, the traps may sample at different locations within the cross-section of the stream, being closer IO the thaiweg during low flows and nearer the shoreline during high flows. This means that daily trap efficiencies can vary greatly around the average seasonal levels given above.

2. The figure has been updated.

3. The number of flsh PIT tagged and freeze branded in 1993, and used in the travel time determinations. are presented on the data tables shown in Appendix F.

4. The harmonic mean {i.e., $(\Sigma t^{-1}/n)^{-1}$, where t=individual travel time estimates and n=number of individuals} may be a viable alternative to the use of medians. The median was chosen in the past because travel time distributions tend to be highly skewed. How adequately the harmonic mean handles highly skewed travel time distributions needs to be investigated.

5. Multi-variable analyses of travel time have been added to the final report for the Snake and Cleatwater trap reieases and Rock Island Dam releases: these analyses were already in the draft report for the McNary Dam reieases.

6. The relation between travel time and flow is curvilinear. Therefore, the following types of relations are potential candidates:
   (i) reciprocal model ------ TT vs FLOW'
   (ii) inverse exponential model --- *ln*TT vs FLOW'
   (iii) exponential model ---- *ln*TT vs FLOW
   (iv) power model - - - *ln*TT vs *ln*FLOW
   (v) hyperbola model ---------- TT^{-1} vs $FLOW^{-1}$

   The water transit time through a reservoir is estimated by dividing the reservoir volume by flow. This is effectively model (i) above. "The similarity of fish travel time to water travel time and what is known about the biology of fish migration suggest that this is the most biologically intuitive model strucrure" (Berggren and Filardo 1993). The reciprocal model (i) and the inverse exponential model (ii) are both used in the 1993 FPC Annual Report. Which of these two models was chosen was based on the strength of prediction (R^2 value) and investigation of residual plots.

7. During periods of high flows, just prior to being forced out of the water, the traps typically receive some of their highest collections for the season. In addition, collections at the downstream dams will increase quickly after the first high flows of the season are reached.

8. **Only** 10% passage dates were presented for the trap data because of early termination of sampling (no 50% and 90% dates are given). The 10% passage dates were presented to simply show when the ourmigration got underway from each drainage sampled.

9. The mean of the median travel time estimates from the daily and blocked-days releases over the season does not seem to be a very useful statistic. Since flow and other factors are shown to be significant covariates in the models generated, it would seem that you would be more interested in the predicted travel times for given values of these covariates.

10. Multi-variable regressions have been added to the final report for the Snake and Clearwater River traps and for the Rock Island Dam reieases.

11. These plots were rough draft copies only; the final report has improved graphics and the regression lines displayed.

12. The sentence has been re-worded.

13. The wording "prevented more than development of a bivariare model.. " has been dropped. The point being made was that the presence of two highly inter-correlated variables in a regression model can adversely impact each other's parameter coefficient. The partial and multiple correlations you suggest can be used to help pick candidate predictor variables for the model. but in the final regression model. highly inter-correlated variables should not be used together.

14. An analysis of covariance was conducted to determine if a significant difference occurred between adjusted mean travel time of hatchery and wild steelhead. after adjusting for the covariate FLOW-'.

15. Multi-variable analyses of travel time for the Rock Island Dam releases are presented in the final report.

16. The term "over time" was replaced with your suggestion.

17. Sentence was reworded.

Chapter V. 1993 Hatchery Releases

1. The number of hatchery fish released in 1993 was reduced by 8% from 1992.

2. The term plotted was deleted from the text and replaced with Figures 45 to 48 depict release totals..

3. Figure number was changed.

Chapter VI. 1993 Adult/Jack Salmon Returns to the Columbia River

1. Radio telemetry work on adult fish was not accomplished prior to 1993; therefore, the fate of the missing fish from the existing fish count data were unknown. In 1993, preliminary data based on this year's study (conducted by NMFS) indicated that fallback occurred at a fairly high rate, 18% was recorded at Priest Rapids Dam. No further data were provided without substantial information to back up the ideas.

2. The paragraph was moved.

Chapter VII. 1993 Adult Fish Passage Facility Operations

1. Replaced dissolved gas rates with dissolved gas levels.

7. The word "normal" is deleted from the sentence,

Sincerely,

Michele DeHart

Michele DeHart
Fish Passage Center Manager

174-94.md

Department of Energy
Bonneville Power Administration
P.O. Box 3621
Portland, Oregon 97208-3621

FEB 1994

In reply refer to: PJ I

JAN 2 3 1994

Ms. Michele DeHart, Manager
Fish Passage Center
250 1 SW. Fist Avenue
Suite 230
Portland. OR 97201

Dear Ms. DeHart:

Please find enclosed our comments to the Fish Passage Center's (FPC) draft Annual Report for 1993. The version we reviewed is dated December 30, 1993.

Thank you for the opportunity to review the draft 1993 report. We look forward to seeing FPC's responses to comments in an appendix in the 1993 final annual report.

Sincerely,

Sharron A. Monohon

Sharron A. Monohon
Chief, Fisheries Integration Branch

Enclosure

BPA'S COMMENTS on
FISH PASSAGE CENTER'S
DRAFT REPORT for 1993

GENERAL COMMENTS

1. We compliment FPC and the SMP contractors for collecting, analyzing, and presenting such a vast amount of information. To turn around this amount of data in the three months or so since the field season ended *is* commendable. And the volume of data seems to grow each year. The hatchery release and adult migration chapters especially show significant improvement over previous reports.

2. The following sections were unavailable for review: Chapter I. Introduction, and Appendices A, B, G, and H. We did not comment on typographical errors, misspellings, and grammar.

3. We suggest that the report would be improved by removing editorial comments and making it purely a technical document. For example, discussing Water Budget (WB) management procedures and policies is beyond the Northwest Power Planning Council's (NPPC) intent. as stated in the Fish and Wildlife Program (Program), for the Fish Passage Center report. The Program calls for a report that includes: *"(A) The actual flows achievedfor that calendar year; (B) A record of the estimated number of smolts that passed Lower Granite and Priest Rapids dams and the period of time over which the migration occurred: and (C)A descripn'on of the flow shaping used for that calendar year to achieve improved smolt survival."* The FPC report should be a factual account of actual flow augmentation activities and other river operations implemented for fish. Editorial comments regarding the merits or flaws in regional policies and resulting conflict over river operations Implemented for fish should be omitted from this report.

4. The authors state that in 1993 juvenile passage between projects was *"enhanced"* and that migration conditions were *"better"* than previous years. Until direct measures of benefits of higher flow and spill levels on juvenile migration, such as <u>survival</u>, can be referred to, we will not have definitive data on the benefits of higher levels of flow. The statement that migrations conditions were *"better"* in 1993 than 1992 should be qualified by noting that this is your <u>opinion</u>. The document should be edited to reflect this.

5. In Section III. C.. 3. you discuss the appropriateness of the Environmental Protection Agency (EPA) Total Dissolved Gas (TDG) standard of 110%. Including this type of policy discussion in a technical report is inappropriate and should be deleted.

6. The 1993 TDG monitoring program described in Section Ill. C. was inadequate to determine the impacts of Gas Bubble Disease (GBD) on juvenile or adult fish. Juveniles and adults were inspected for GBD only at smolt monitoring sites (dams) and were only those that survived to reach that particular site. The monitoring

program needs to include <u>reservoir</u> monitoring and internal examination of juvenile and adult migrants. Since no reservoir monitoring was conducted. the program did not detect dead or distressed fish and, therefore, could not estimate the impact of high TDG levels on juvenile and adult survival.

7. References are made in Section III that spill at Ice Harbor Dam (IHR) was provided to achieve 70/50 Fish Passage Efficiency (FPE). These statements are incorrect. Spill levels at LHR were set by the National Marine Fisheries Service's (NMFS) 1993 Biological Opinion (BO) which adopted spill levels from 1992. During Section 7 consultations between NMFS, the U.S. Army Corps of Engineers (COE) and the Bonneville Power Administration (BPA), NMFS estimated that to provide 70% FPE at IHR would require 100% spill. Due to concerns about adverse impacts of high TDG levels to juvenile and adult migrants, the agencies <u>negotiated</u> 60% and 30% of instantaneous flow, up to a maximum of 25 kcfs, spring and summer spill levels, respectively. These spill levels were never designed to achieve 70/50 FPE at IHR. We suggest that the report be modified to reflect this fact.

8. Regressions between travel time and flow should include an analysis of the apmess of the bivariate model used. By aptness we mean: linearity of the regression function, constant error variance, independence and normality of error terms, presence of outliers, and omission of important independent variables. Results of this analysis for the regressions presented in the main text could be summarized in an appendix.

9. Regression data need to include information on P-values of the regression coefficients. And. when you say a relationship is statistically "significant", it would help to state the P-value. The report should be consistent on reporting significance: stating significance in some cases and not others leads the reader to believe relationships are not significant when nothing is said about significance.

10. Regressions are presented for the relationship between travel time and flow. The analysis would be improved if additional independent variables were included, such as release date. temperature, indices of smoltification, and stock. Focusing the analyses primarily on flow neglects other potentially important predictor variables. Please incorporate multivariate analyses of travel time in the final report.

11. Descriptive comparisons are made between 1992 and 1993 for various parameters, such as travel time, and conclusion drawn about which year was "better". No statistical comparisons between 1992 and 1993 are included. We suggest such additional analyses would improve the report.

SPECIFIC COMMENTS

Executive Summary

1. Page x: We suggest that the executive summary begin with a statement of the report's topic and objectives of the project.
2. Page xi, second paragraph: We propose deleting this paragraph because it is redundant with preceding paragraphs and contains statements not supported by data.
3. Paee xii, fifth paragraph: It is inappropriate to include references to figures in an executive summary.
4. Page xii, sixth paragraph: The statement is made that *"Flows were much higher in 1993, and the corresponding travel times were much faster than those observed in* 1992" for the yearling chinook migration between the Lewiston trap and Lower Granite Dam (LWG). Please include 1992 data for comparative purposes.

   In addition. the same 1993 data presented here are also presented, with additional supporting data, in a November 10, 1993 memo from the Fish Passage Manager to the directors of the fishery agencies and Tribes (A&T's). The memo concludes that yearling chinook travel times from the Clearwater and Lewiston traps to LWG and Little Goose Dam (LGS) to McNary Dam (MCN) were *"much faster"* in 1993 compared to 1992. However, these conclusions do not appear to be supported by the data presented. Ranges of travel times for yearling chinook for the river reaches mentioned previously were nearly the same in 1993 as in 1992, under very different flow conditions. We suggest statistically comparing the 1992 and 1993 yearling chinook travel time data. Definitive conclusions usually are based on statistical tests and not averages or ranges of data.

Chapter II: 1993 Operations

1. Paae 1, first paragraph: The statement is made in reference to Pacific Northwest Coordination Act (PNCA) planning that *"...minimum power flows and elevations had been establishedfor the year"*. This statement is incorrect. PNCA planning does not establish either minimum flows or minimum reservoir elevations. Please delete this statement from the text.
2. Page 2, Table 2: Please define which years are used in *"% ofaverage"*.
3. Page 3, Table 3: The text in Section B and the heading on Table 3 do not correspond. The text describes precipitation while the table presents runoff volume data. These are two very different water measurements. The text needs to be altered to be consistent. Also. in Table 3 please include the date of the final runoff volume forecast.
4. Paee 3, second paragraph: Text after the first two sentences should be deleted as it has nothing to do with describing the 1993 Water Supply. This editorial on 1993 system operations does not belong in FPC's technical report.

5. <u>Panes 4-I I. Figures 1-6</u>: These figures and accompanying discussion show how 1993 flow levels differed from 1992 flow levels. However. the true measure of effectiveness of these increased flow levels is how juvenile migrants responded. We suggest making these figures. and the accompanying discussion, more powerful by plotting juvenile fish passage data along with flow and spill data. Also, please improve discrimination between 1992 and 1993 data in the figures and the X-axis is mislabeled (use month/day instead of month/day/year).

6. <u>Pane 5. fourth paragraph</u>: The statement is made *"For the 1993 spring migration in the Snake, runoff volume and flows were much higher than recent years marking the end of a* six year drought." This statement is incorrect. Although the runoff volume and observed peak flow level in the Snake River was higher than previous years, the final 1993 January-July runoff volume at Lower Granite (LWG) was 26.1 million-acre-feet (MAF), which is only 88 percent of normal (50 year average). The April-August runoff was near normal (98%). Drought, or below normal, conditions still existed in both the Snake and Columbia rivers in 1993. Please modify the paragraph accordingly; the recent six-year drought is <u>not</u> over.

7. <u>Page 10. first paragraph, second to last sentence</u>: Did you mean to say *"August"* instead of "July"?

Chapter KU: 1993 Spill Implementation

1. <u>Page 14. second paragraph</u>: Please document methods for the dissolved gas monitoring program in an appendix. For example, please include the *"pre-determined criteria"* used to rank fish.

2. <u>Page 15. first paragraph</u>: This paragraph is editorial and political in nature. It should be removed from FPC's technical report.

3. <u>Paee 15. second and third paragraphs</u>: Reference is made to *"overgeneration spill"* and *"Load distribution problems....even when units were available for operation."* Rather than *"overgenerarion spill"*, the technically correct term to use is spill due to lack of market. That *"Load distribution problems"* caused excessive spill is a mischaracterization of river operations in 1993. Spill on the Snake and Columbia rivers was <u>disuibuted</u> according to the Spill Priority List developed by the Fish Passage Center (FPC) as modified by the Corps of Engineers (COE).

4. <u>Pages 16-23. Figures 8- 15</u>: All references in the text and in Figures 8-15 to 80/70 or 70/50 Fish Passage Efficiency (FPE) standards should be omitted from this document. There is no regional FPE standard that has been agreed on by all parties or demonstrated to be biologically valid. Again. editorial/policy comments do not belong in a report that should be a factual account of spill implementation on the Columbia and Snake rivers in 1993.

5. <u>Page 19, second full paragraph, fifth sentence</u>: Please reword this particularly unprofessional sentence.

6. Page 24-31: In the section on Dissoived Gas Supersaturation. it would help if data were presented in tables and/or figures. and not just described in the text.
7. Paee 24, third paragraph: Since gas supersaturation can have effects on resident fish and invertebrates as well as anadromous fish. we suggest adding resident to the presentation.
8. Page 24. third paragraph, fourth sentence: This sentence is neither accurate nor professional and should be reworded or deleted. Federal agencies are expected to comply with water quality standards, including gas supersaturation. hence COE has an obligation that cannot be dismissed by the FPC, fishery agencies or tribes.
9. Page 25. first paragraph: "...*ignored* the advice..." is neither accurate nor professional and should be reworded.
10. Page 25. second paragraph: Daily average levels of total dissolved gases should be included. but averages do not accurately describe the danger. Exaemes are what kill organisms, hence ranges should be included, too. For example, the average between freezing and boiling is a fairly comfortable temperature.
11. Pane 25. second paragraph: The statement that "*...it is apparent that the impacts of high dissolved gas saturation on fish were minor in* 1993" cannot be made with any level of certainty because no survival data were included in analyses of TDG impacts on juvenile migrants in 1993. This statement should be revised or deleted from the document.
12. Page 25. third paragraph, first sentence: The term "*mild*" is inappropriate, as the fish's prognosis cannot be judged from external signs. Rather, a quantitative descriptor should be used, e.g. "*few, some, or many*".
13. Paee 25. third paragraph. third sentence: This appears to be inaccurate as trauma is different than external signs of it. As we understand it. the *crew* only looked for externally evident dermal emphysema. These do not begin to describe the incidence of GBD. which is based on internal emphysema and emboli.
14. Page 25. third paragraph. third sentence: Since the observations were made only on migrating smolts, we do not know what level was in the resident fish. Furthermore. it is potentially very serious to have this level of external signs in a wild population. especially over a 19 day period.
15. Page 26. first paragraph: Please clarify whether these are daily averages or extremes. If daily averages. these levels are very serious.
16. Page 27. last paragraph: For nearly 100 years. the impact of gas supersaturation in fish has been and still is known as "gas bubble disease" in the United States. John Jensen and Don Alderdice hold that Canadians should call it Gas Bubble Trauma. That is not good enough reason to confuse everyone by replacing the term gas bubble disease. anymore than it would be to discard the term "bends" in human divers. Please replace GBT with GBD.
17. Page 28, first paragraph, first sentence: Did NMFS record the incidence of external and internal signs of GBD? If so, please describe this information.

18. Paee 28. first paragraph, fourth sentence: Again, the term *"mild"* is judgmental about the prognosis which cannot be inferred from the external signs.
19. Page 28. first paragraph, sixth sentence: The occurrence of these dead steelhead in the raceways merits expansion. Did anyone perform a necropsy examination? If not, why not? If yes, cite the information. What conclusions were reached and based on what signs? What were the gas levels in the raceway and flume'?
20. Paee 28. second paragraph: Please describe the sampling location, method, and all results. Also be aware that GBD signs are not equally distributed between steelhead and coho or other species.
21. Page 28. third paragraph, second sentence:We suggest including a copy of the cited memo in an appendix.
22. Page 28. third paragraph, fourth sentence: It might be best to advise the reader that you did not look for internal signs of gas bubble disease and therefore, cannot accurately describe how many of the adult fish had signs of gas bubble disease.
23. Page 29. first paragraph: *"Head burns"* is the current term for a generalized lesion that has been observed under similar conditions for a long time. While not pathogonomic to supersaturation per se, the lesion could be the indirect result of gas emboli impairing the lateral line or vision, i.e. by obstructing the ophthalmic artery or rete. Impaired vision would promote collisions with structure and if blindness results, the fish is unlikely to spawn. If the cause is supersaturation, the primary damage probably happened well downstream from this location. The report would benefit from expanding the discussion on this very important problem.
24. Page 29. second paragraph, second sentence: What happened in 1993 was not truly *"debate."* We suggest using the term "discussions."
25. Page 29. second paragraph: Granted that the 110% standard and criterion has been criticized, but it has also been supported by the National Academy of Sciences, EPA, and others. This fact should be included in the discussion.
26. Page 29. second paragraph, third sentence: We do not think *"common sense"* is a valid criterion. There is no standard for it and in reality it does not exist. In our opinion it is not appropriate to worsen the situation when the EPA and Oregon gas standard are already exceeded.
27. Page 29. third paragraph, second sentence: Since no one is looking for the internal lesions from supersaturation, please explain how can you tell that these conditions are safest for all life stages, and all species of fish, especially adult salmon.
28. Page 3Q: We suggest that this page especially should be edited to achieve communication standards for professional reports.
29. Paee 3 1. second paragraph: Please include a citation for Ringe's investigation. Were the fish anesthetized'? What parts of the fish were examined externally and internally?

30. Page 32. first paragraph: We suggest including a discussion of how the 1993 spill conditions compare with conditions that existed when Ebel reported heavy mortality to smolts.

31. Page 32. third paragraph, second sentence: This has merit, but only within *certain* limits which have not been defined. Conversely, if a fish is critically supersaturated, and the gas level is sharply increased, it can trigger mortality from a "cascading bubble effect." Thus, dissolved gas peaking is largely unexplored, but should be considered questionable at best.

32. Page 32. third paragraph, fourth sentence: For *clarity,* insert *"anadromous"* in front of *"fish"*.

33. Page 33: As stated above, resident fish need to be addressed when considering impacts of supersaturation.

Chapter IV: 1993 Smolt Monitoring Program

1. Pages 34-36: Please summarize data on trap collection efficiencies, by species and water velocity if possible, to give the reader a feel for how representative the sample is.
2. Page 35. Figure 18: Update for 1993 SMP, instead of using 1992 SMP.
3. Page 41: To help the reader, we suggest including a table summarizing number of fish tagged and branded, by species and location.
4. Page 44. second paragraph: We suggest that FPC investigate an alternative to using medians to estimate of travel times. This alternative, using the harmonic mean, is described by Skalski and Giorgi (1993, Juvenile Passage Program: A Plan for Estimating Smolt Travel Time and Survival in the Snake and Columbia Rivers, DOE/BP-35885-3). These authors feel the harmonic mean is more amenable to sample size calculations and provides more meaningful smolt travel "speed" information than the median.
5. Paee 44. third paragraph, second sentence: You state that a series of variables were considered in the analyses of travel time, yet to our knowledge these analyses were not presented in the draft report As appropriate, please include such analyses in the final report.
6. Page 44. third paragraph, third sentence: For clarity, we suggest replacing *"with a reciprocalflow structure"* with *"using the reciprocal of flow as the independent variable."* Please explain why the reciprocal transformation is used in the regression instead of the untransformed flow variable.
7. Page 44, fourth paragraph, first sentence: Please replace *"...which **often coincide...**"* with *"...which **may coincide...**"* If you cannot sample during high flow periods, how do you know these periods often have high passage'?
8. Page 45. first paragraph: The 10/50/90% migration timing data are somewhat equivocal because the traps cannot sample during periods "which may coincide with

periods of peak passage". Because of this, we propose you omit the 10/50/90% data and instead describe data from the figures in Appendix D in this paragraph.

9. Page 62. first paragraph: Here and other places in the report. please provide mean travel time estimates along with the ranges.

10. Page 62. second paragraph: As stated above, here and in other places where travel time is related to only flow, please include multiple regression analyses using other independent variables besides flow.

11. Page 63. Figure 23: This figure is hard to read. We suggest enlarging these plots and improving discrimination between hatchery and wild fish data points. Please explain why there is a regression curve in (c) and not the other plots.

12. Page 64. third paragraph: This paragraph should be reworded because the data do not support the statement that 1993 travel times were "much faster than any observed in 1992", assuming the maximum travel time corresponds with the minimum flow. The data presented say:

Year	1992	1993
Max. Travel Tie	11.6 days	13.4 days
Min. Flow	37 kcfs	63 kcfs

13. Page 65. fust paragraph: High inter-correlation among variables should not have "*prevented more than development of a bivariate model . ..*" Partial and multiple correlation techniques are useful when independent variables are highly inter-correlated.

14. Page 68. last paragraph: Did you mean to say analysis of variance instead of an analysis of covariance? If not, please define the covariate.

15. Page 70. third paragraph: Please present statistics of this analysis. This type of multiple variable analysis is valuable, but this is the only example we noticed in the entire report.

16. Page 75. first paragraph, third sentence: This sentence might be improved by adding "*as the outmigration season progresses.*"

17. Page 76: The first sentence needs to be clarified. Perhaps change it to read: "*Similar to other reaches, an increasing ...*"

Chapter V. Hatchery Releases

1. Paee 77. first paragraph: Although stated later in the report, please describe here how much (percentage) the number of hatchery fish in 1993 was reduced from previous years.

2. Page 8 1. first paragraph: It says hatchery release totals were plotted. *Where are* the plots'?

3. Page 82. third paragraph: We believe you mean Figure 29, not 33.

Chapter VI. Adult/Jack Salmon Returns To the Columbia River

1. Paee 94. second paragraph: The reader is left hanging as to what may have happened in 1989. If possible, provide some ideas.
2. Page 100. last paragraph: This paragraph belongs in the chapter on adult facilities.

Chapter VII. Adult Fish Passage Facility Operations

1. Page 101, first paragraph: Replace "dissolved gas *rates*" with *"dissolved gas levels."*
2. Page 101, second paragraph, third sentence: Sentence is unclear. Why is *"(normal)"* in the sentence?

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